POWER PLANT ENGINEERING

Established Over 34 Years

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Contents of this Issue

	Page
Power for a New American Industry	420
Radiant Superheaters Find Wide Application	427
Keeping Step With St. Louis	429
Turbo Versus Turbine Generator	430
Power Plant Materials-Handling Tools—II. By W. W. Sayers	433
Buffalo to Have 75,000-Kw. Unit	436
Power from Process and Space Heating Steam. By L. A. Harding	437
Determination of Phosphate in Boiler Water	448
Control Equipment for Synchronous Motors—III. By C. P. Robinson	439
Diesel Engine Upkeep—I	442
Electricity—What It Is and How It Acts. By A. W. Kramer	444
Electric Eye Watches Smoke Conditions	447
Georgia Power Co. Builds New Steam Plant	448
Simple Cost System for Small plants. By R. F. Leach	449
Paper Mills Find Economy in Central Power Plant	450
Illinois Utilities Meet in Springfield	451
Adjustable Blade Propeller Runners at Back River Plant	452
Industrial Substations—I. By Ottomar H. Henschel	453
Variable Speed Devices Aid Economy. By E. J. Patton	455
Routine for Lubricating Systems. By Herbert L. Schultz	458
Pipe-Joint Compounds	462
Cork as a Noise Eliminator	462
Insulation of Coolers in the Meat Packing Industry	463
New Vertical Unaflow Engine	464
Letters Direct from the Plant: Superheater Element Leaks. Tri-Sodium Phosphate Controlling Boiler Concentration. Flexible Coupling Repair by Rubber Tube. Diesel Engine Needle Valve Upkeep. Corliss Valve Setting Without Indicator. Electric Lights for Safe Use in Boilers. Chain to Remove Tuyere Rods.	467
Questions and Answers: Steam Savings from Changed Installation. Refrigeration Installation Improvement. Unusual Savings by Change in Installation. Boiler Blowdown	470
Editorial Comment: A New Spirit in Industry. The Photo-Electric Cell Enters the Power Plant	472
Off Duty	473
High-Pressure Flow Meter	474
Flexible Coupling	474
Wide-Radius, Broad-Gage, Heavy-Duty Derrick Crane	474
New Line of Westinghouse Voltage Regulators	475
Fourth Unit for Mistersky Power Station, Formerly Morrell St.	475
Production of Electricity and Consumption of Fuels	475
Fifth Annual Byllesby Engineering Convention	477
News Notes	477
Catalog Notes	479
Power Plant Construction News	480

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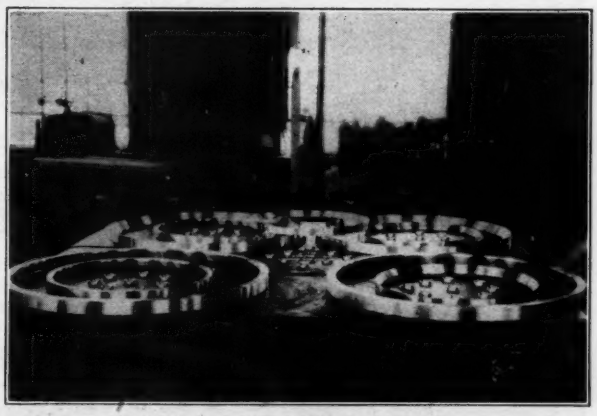


$30,000 Worth of Zeros

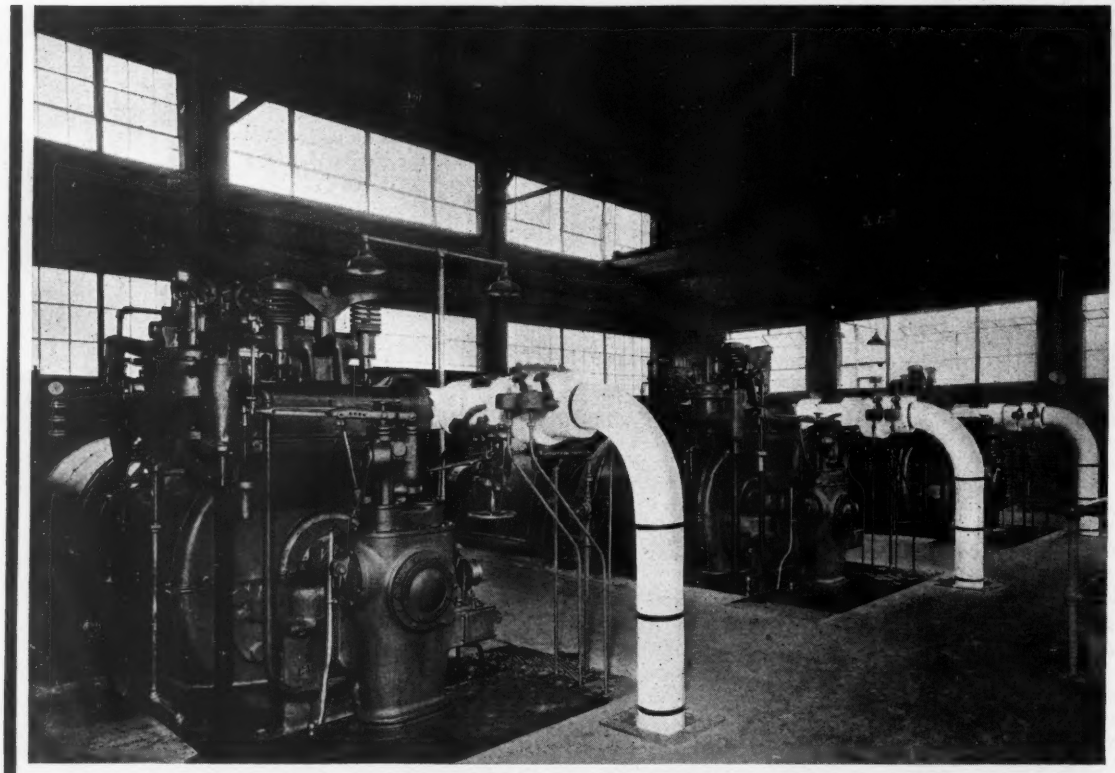
YOU HAVE often pondered, no doubt, on the great importance of zero. When you stop to think of it, the man who first conceived the idea of zero probably made the greatest contribution to modern civilization that can be imagined for, without some kind of a number to denote entire absence of anything, our present system of numbers and the calculations based on them would never have been possible. If you are inclined to doubt the importance of zero, just try, as the Romans did, to multiply MMCLIII by CCCLXXXIV and then add MCIX to the answer. Also, try to think of a system that does not involve zero and that will allow you to express minus quantities or numbers less than nothing!

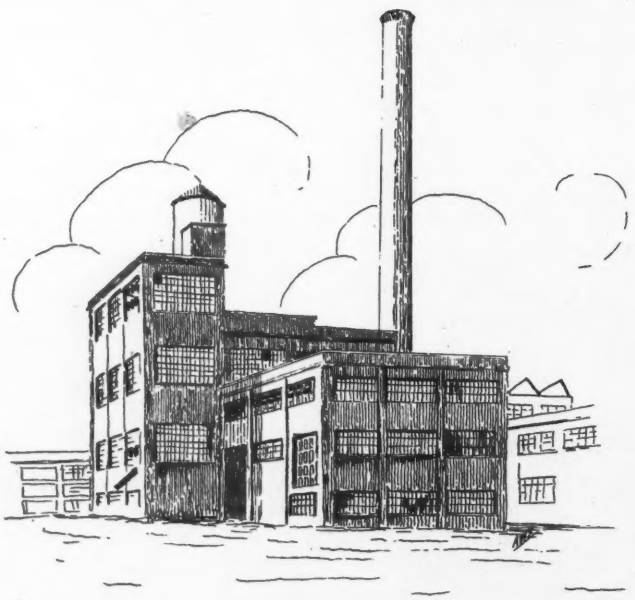
Now the symbol for zero can be recognized only if its rim is visible, because with mathematical precision, the number is true to its name and has absolutely nothing inside it. The zeros shown in the above picture, however, were so important that their rims had to be made of solid silver to the tune of some $30,000.

These particular zeros with the silver rims are to be used as gaskets in certain process equipment of a great chemical company. They are seamless and required a ton of pure silver in their manufacture. Some of them are 45 in. in diameter and 2 in. thick. To meet the specifications the machining had to be done at a shop temperature of 60 deg. F. in the factory of Goetze Gasket & Packing Co., Inc., where they were made. The sealing surface is at an angle of 30 deg. 12 min. 7 sec. and a special annealing process brought the hardness down to 50 Brinnell.

Such problems are not common, of course, in fabricating joints in industrial plants. But the fabricating of piping joints and fittings in such plants constantly presents other problems that are solved in various interesting ways. Many of these methods are discussed elsewhere in this issue, in an article on page 462 by Mr. Kauffman.

POWER FOR A NEW





Three extraction type turbine generators taking steam at 400 lb. pressure and at 150 deg. superheat, supply electric power and steam at 17 lb. pressure to the factory at the American Salpa Corporation.

AMERICAN INDUSTRY

American Salpa Corporation Commences Operation of New Plant For the Manufacture of Reconstructed Leather at Spotswood, N. J.

NEAR SPOTSWOOD, New Jersey, which is some 40 mi. out of New York City, on a plot of ground which until a year ago was rolling country, there has been erected recently a large manufacturing plant, as modern and as fully equipped as any in this country. This plant, that of the American Salpa Corporation, will be devoted to the manufacture of a reconstructed leather.

This is a comparatively new industry. It was started in Europe several years ago, under the name of S. A. Lavorazioni Pellami (Salp) of Turin and Milan. The plant under consideration here is an American subsidiary of the Salp, and at the time of this writing is just about to go into production. The leather is not like "artificial leather" which is manufactured by coating a cloth base with pyroxylin and resembles leather only in the surface appearance. The product made by the American Salpa Corporation made from leather scrap is formed into a homogeneous product which simulates the properties of genuine leather.

Included in this development is a new power plant, which will supply all the necessary electric power, heat and light for manufacturing operations and is so designed with respect to the particular power requirements of the plant that the overall cost of power, heat and light will be reduced to the lowest possible figure. A connection is provided with the power lines of the local public service company, however, so that in case of any serious trouble with the power generating equipment, production in the factory will be maintained.

At the present time, the power plant consists of three turbine generators, totaling 1750 kw. capacity and two 556-hp. boilers operating at about 400 lb. pressure. Provision has been made, however, for the future installation of another 1000-kw. turbine generator and an additional boiler. This future equipment can be accommodated in the present buildings. Should still more capacity be required, the plant is built so that it can be extended both ways, that is, both the boiler and turbine rooms can be extended.

All turbines are of the extraction type, operating condensing and using steam at 400 lb. pressure with about 150 deg. superheat. Extraction steam at 17 lb. is all used in the factory, but connections are provided so that extraction steam can be used for feedwater heating if this becomes necessary. Ordinarily, the feedwater is heated by exhaust steam from the boiler room auxiliaries.

An exterior view of the power plant is shown on page 425 and in Fig. 3G and in the airplane view on page 424, may be noted its relative location with respect to the other factory buildings. It is a brick and steel structure with concrete floors, and is one of the few power plants that the writer has ever been in which during the daytime, no artificial illumination of any kind is necessary anywhere in the plant. Ample space has been provided around all of the equipment affording ready accessibility and freedom of movement.

Coal Is Burned on Stokers

Coal delivered to the plant by railroad is fed directly into a track hopper and then by means of an apron conveyor is delivered to a crusher in the basement of the boiler room. After being crushed, the coal is carried by means of a bucket conveyor to the overhead steel bunkers in the boiler room. All coal handling equipment was installed by the Specialty Engineering Co. of Philadelphia. A weigh larry equipped with a Howe scale is provided to transfer the coal from the overhead bunkers into the stoker hoppers, weighing and recording it in the process. This coal handling system is simple and effective and for a plant of this size and type is capable of taking care of future requirements. At present, the coal bunker runs the entire width of the boiler room.

A Browning locomotive crane is provided for handling coal to and from storage. The storage pile is maintained outside the power plant adjacent to the turbine room.

Ash, also, is disposed of simply. Each boiler is provided with ash and soot hoppers which discharge directly into ash cars in the basement. These transfer the ash to the bucket of a vertical skip hoist whereby it is elevated to the top of the boiler house, where the end section of the steel coal bunker serves as an ash storage bin. Here it is stored until such times as it can be removed by trucks. The ash hoppers are fitted with Beaumont ash gates.

Badenhausen Boilers Installed

Steam generating equipment consists of two 556-hp. Badenhausen boilers, built for a working pressure of 402 lb. and fired by Taylor underfeed stokers. A cross section of one of these boilers is shown in Fig. 1. As may be noted, it consists of two essential parts, one (the rear) consisting of two drums with a nest of vertical tubes serving as an economizer section and the other the boiler proper. The latter section consists of two water drums and two steam drums. The two water drums and the rear steam and water drum are connected by means of tubes so as to form a circulation system for the water. The steam drum is connected through the water column opening to the lower front drum.

An interesting feature of this boiler is the arrangement of the superheater. The superheater elements are

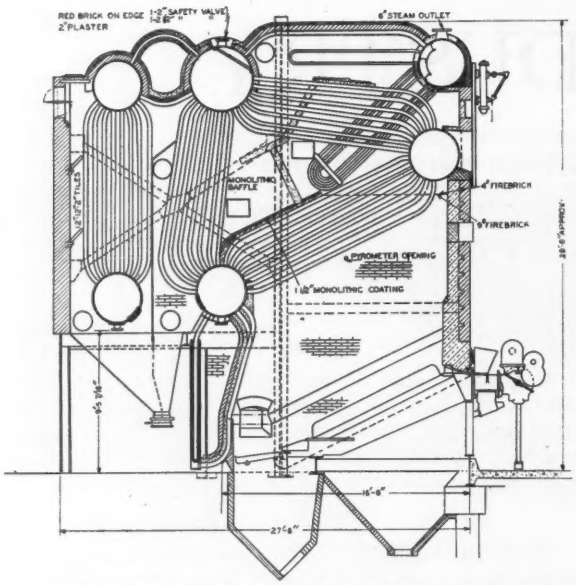


FIG. 1. CROSS SECTION THROUGH ONE OF THE BOILERS

expanded directly into the steam drum without the use of a separate header. There are, in fact, two superheater sections, one extending downward obliquely and the other extending horizontally. Steam collected in steam drum No. 3 passes through the upper circulating tubes into steam drum No. 4. Here, by means of a baffle arrangement, it is sent through the horizontal superheater elements and then into the inclined superheater elements from which it emerges into the main body of the steam drum.

The boiler setting requires no particular description, its design will be evident from the cross section. The furnace has a water-cooled rear wall and carborundum blocks on side walls, on front and on dump plates. All boiler brickwork was installed by the Rust Engineering Co. of Pittsburgh.

The Taylor stokers are of the 33-tuyere type, each driven by a 4-speed Louis Allis induction motor, mounted directly on the stoker casing and controlled by hand.

At present, the boiler pressure carried is about 400 lb. with about 95 deg. superheat. The only other steam pressures carried are the 17-lb. extraction pressure from the turbines to the mill and the 150-lb. line to certain of the boiler and turbine room auxiliaries. The 150-lb. steam is desuperheated.

Both forced and induced draft are used. The former is installed in the basement underneath the firing aisle while the latter is placed on the operating floor directly behind the boilers. There are two forced draft fans, both Sturtevant, turbovane units, one driven by a 20-hp. Louis Allis multispeed induction motor and the other by a Sturtevant steam turbine. Both fans deliver air into a common duct of steel plates with welded joints. The motor-driven fan damper and the turbine-driven unit are controlled automatically by the Engineer Co. draft control system installed in this plant.

Induced draft is obtained by means of a Sturtevant multivane fan, belt driven from a 60-hp. General Electric induction motor. This fan is installed on the operating floor in the boiler room as shown in Fig. 3F; it is large enough to take care of all boilers including future unit No. 3. The duct arrangement is shown diagrammatically in Fig. 4. At light loads, the fan may be bypassed if desired. No air preheater is used. All breeching was installed by Connery & Co., Inc., and the brick stack by Kellogg.

Each boiler is fitted with the following appliances: Reliance gage column with inclined water column, Copes feedwater regulator, Vulcan soot blowers, Ashton safety valves, three on each boiler, Yarway tandem blowoff valves and Crane stop and check valves, Kellogg Copper ring gaskets.

Steam flow from each boiler is indicated by a Bailey flowmeter, and the draft in the main forced draft duct, over the fire and in the last pass, is shown by a Precision Thermometer & Instrument Co. multiple draft gage. There are also installed flowmeters which measure the total flow to the three turbines, and the amount of process steam from the turbine.

The flue gas temperature is measured by a Brown pyrometer. While at the present time no CO_2 meters are installed, it is the intention to install these in the near future.

Feedwater Supply

Water for both boiler and factory purposes is taken

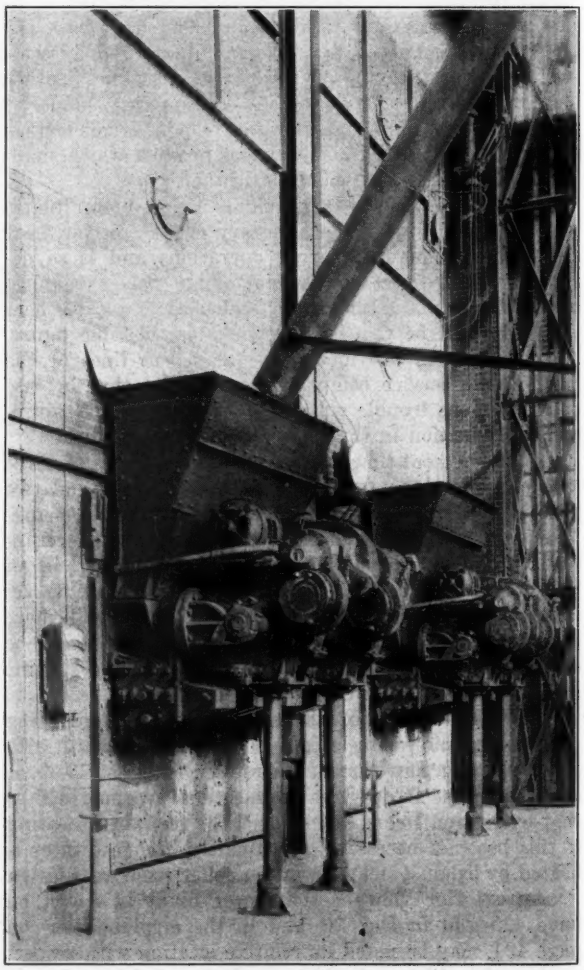
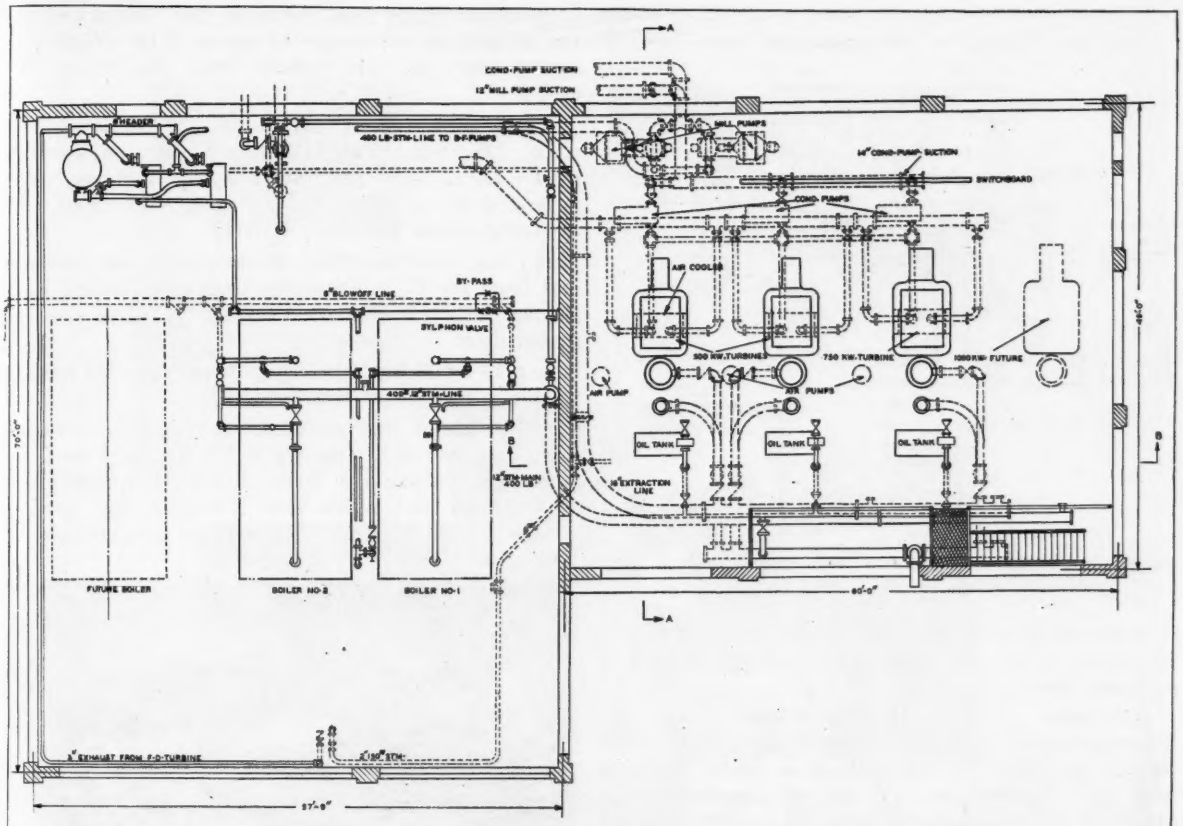
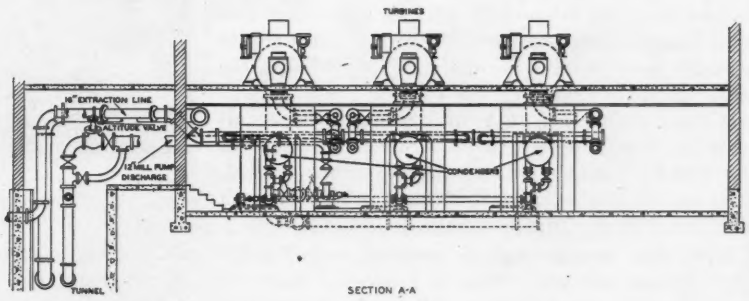


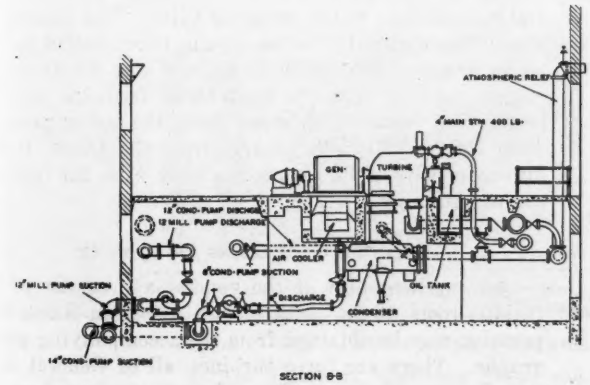
FIG. 2. MOTORS FOR DRIVING THE STOKERS ARE MOUNTED DIRECTLY ON THE STOKER CASING



These drawings show the arrangement of the equipment in the plant. Above is shown a plan and in the other two views are shown side and end elevations.



SECTION A-A



SECTION B-B

All three condensers it will be noted are connected into a common circulating water system. The water after having passed through the condensers is sent by the mill pumps into the factory for process purposes.

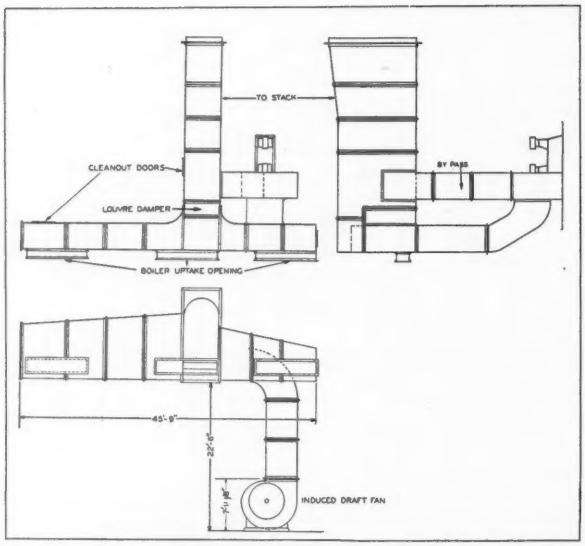


FIG. 4. DETAILS OF BREECHING CONSTRUCTION AND ARRANGEMENT OF INDUCED DRAFT FAN

from four deep well pumps, each of which delivers about 800 g.p.m. This water has been found very good and produces practically no scale.

The water system at this plant is somewhat unique. Referring to Fig. 5 the 4 deep well pumps deliver water for all purposes into one-half of a double concrete reservoir. Water from this side of the reservoir is drawn by the circulating pumps and sent through the condensers into the other half of the reservoir. The water in this half of the reservoir is at a slightly higher temperature than that in the delivery side. From the condenser discharge side, the main service water pumps send it through an Elliott twin strainer to the mill where it is used in process work. Since the processes call for water at a temperature slightly above normal, this scheme of passing all the factory water through the condensers is one that is highly desirable.

A large steel storage tank is provided, both for fire and for general service. This is connected into the system as shown on the diagram. Water for boiler feed makeup is drawn from the common supply line leading to the mill and passes into an Elliott deaerating type heater and is then pumped into the boiler. All returns from the mill are delivered into the heater, which results in a very low makeup. The feedwater heater is supplied

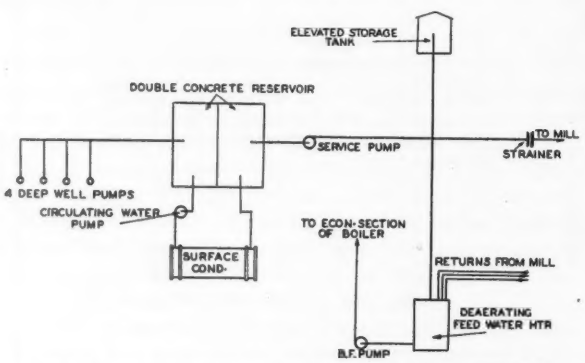


FIG. 5. SCHEMATIC DIAGRAM OF WATER SUPPLY SYSTEM

with exhaust steam from the boiler feed pumps and the fan turbine at a pressure of about 2 lb. With this arrangement, the temperature never goes below 212 deg. F.

There are two boiler feed pumps, both De Laval, 3000 r.p.m., 225 g.p.m., at 995 ft. hd., centrifugal units driven by De Laval 3000-r.p.m., 400-lb. press. turbines. For governing the pressure, these pumps are provided with De Laval excess pressure regulators.

Drains from the 400-lb. steam lines to the turbines and from the 17-lb. extraction lines are collected by 4 Strong Carlisle & Hammond traps installed on the condenser floor.

An 18 by 10 by 10-in. fire pump is installed next to the boiler feed pump behind the boiler.

A feature of interest is the reducing valve arrangement between the 400-lb. and the 150-lb. high pressure steam line serving the forced draft fan turbine, soot blowers, air compressor and the steam jet vacuum pumps. This reduction in pressure is accomplished by

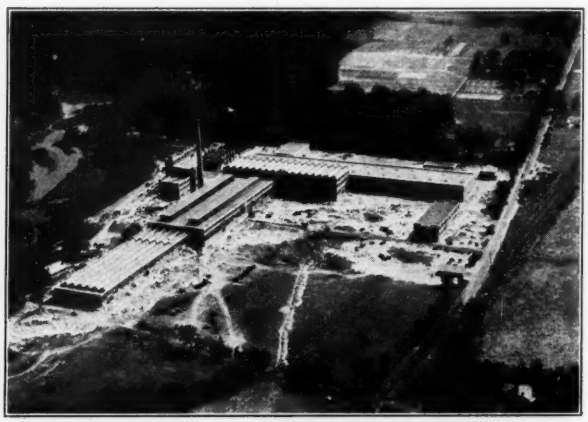


FIG. 6. AIRPLANE VIEW OF AMERICAN SALPA CORPORATION PLANT AT SPOTSWOOD, N. J.

a crane chronometer valve operated by an Atwood and Morrill regulator. This regulator is operated from the 150-lb. side of the system. Since the 400-lb. steam is superheated and since in the pressure reduction the superheat tends to increase, a desuperheater has been provided. This consists of a water spray placed in the 150-lb. line close to the reducing valve. The amount of water thus sprayed into the system is controlled by the temperature of the 150-lb. steam. Water for this purpose is obtained from the main boiler feed line through a reducing valve which steps down the water pressure from 400 lb. to 150 lb. Steam from the 150-lb. line is also reduced to 17 lb. for process work when the turbines are not running.

Electric Generating Equipment

An excellent idea of the general appearance of the turbine room at the plant of the American Salpa Corporation may be obtained from the accompanying photographs. There are three turbines, all of General Electric Co. manufacture. Two of these are rated at 500 kw. and the other at 750 kw. A future unit of 1000 kw. is contemplated and space has been left to accommodate this unit.

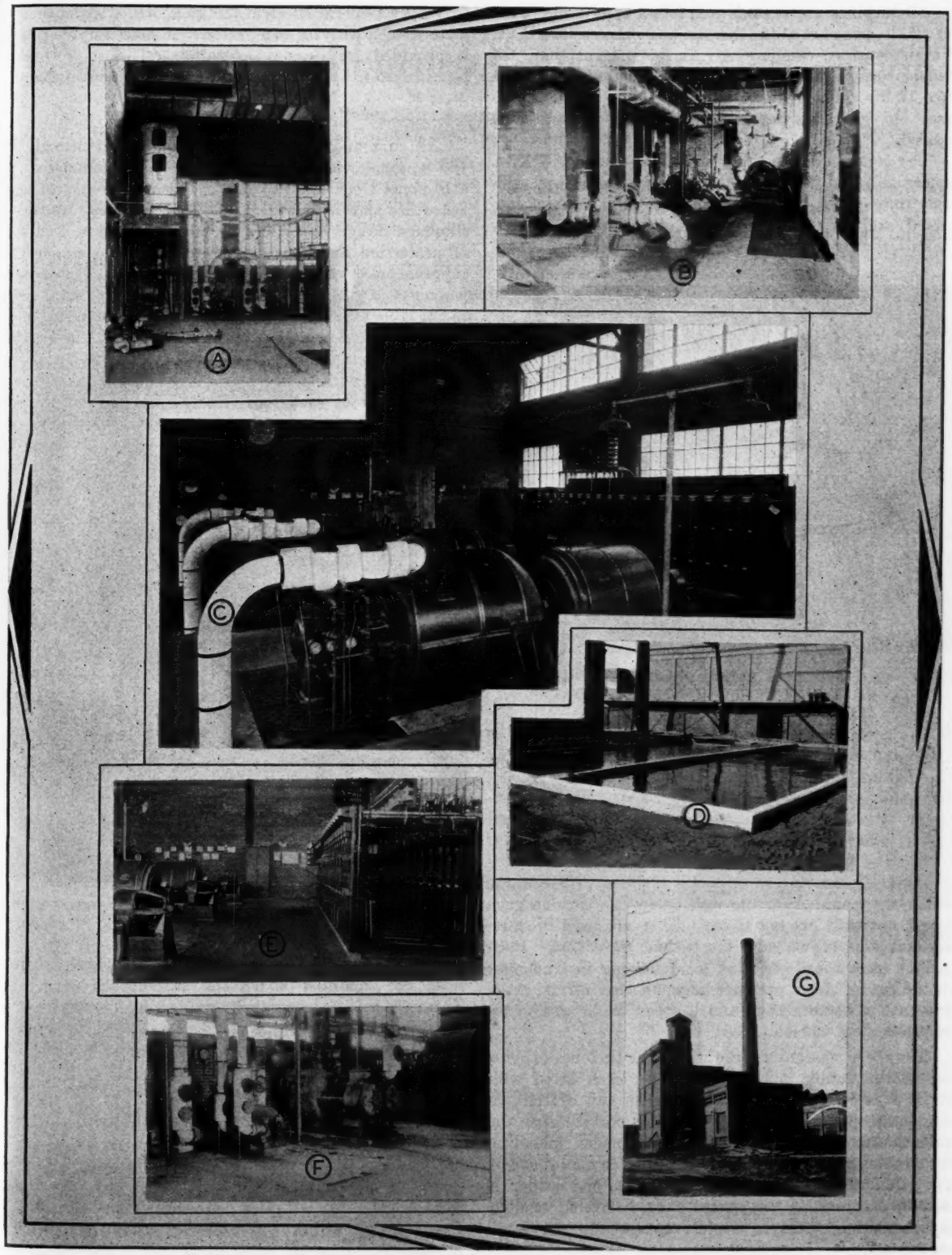


FIG. 7. VIEWS AT THE PLANT OF THE AMERICAN SALPA CORPORATION

A. The deaerating feedwater heater and the boiler feed pumps. B. A view on the condenser floor showing the circulating pumps and the service pumps. C. The turbine room showing the 750-kw. unit in the foreground. D. The double reservoir. E. The main switchboard showing the arrangement of the oil circuit breakers and the operating mechanism. F. The boiler feed pumps, the fire pump and the induced draft fan. G. An exterior view of the power plant

All turbines are 6 stage extraction type units, built for 400 lb. pressure at the throttle and exhaust into C. H. Wheeler surface condensers. At the present time, the steam pressure is about 400 lb. and the extraction pressure 17 lb. This steam is all used in the factory processes but can also be used for heating feedwater if desired.

The generators are rated at 625 kv-a. and 937 kv-a. respectively for the 500 and 750-kw. turbines and generate three-phase, 60-cycle current at 480 v. Direct connected exciters of 9 kw. and 12 kw. capacity supply excitation current for the individual generators.

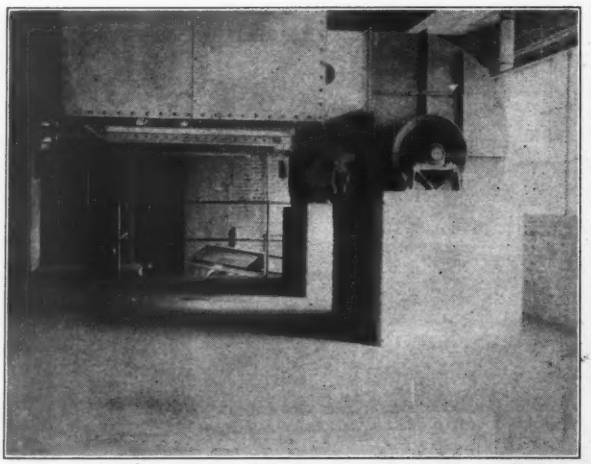


FIG. 8. TWO FANS, ONE MOTOR DRIVEN AND THE OTHER TURBINE DRIVEN PROVIDE FORCED DRAFT

For emergency, a spare exciter is installed. This is a General Electric Co., motor-generator set consisting of a 25-hp. induction motor driving a 16-kw., 125-v., direct-current generator. General Electric fin tube generator air coolers and oil coolers are part of the generating equipment.

Each of the three turbines has a separate auxiliary oil pump driven by a small steam turbine. These units, which are mounted on the wall below the turbine gage board, normally are not in use. They are used in starting and stopping to raise the turbine governors. Each turbine gage board contains the following instruments: an indicating steam pressure gage, another for 1st stage pressure, a vacuum gage and a speed meter graduated in per cent of normal speed.

The three condensers into which the turbines exhaust are of the double pass surface type, each fitted with C. H. Wheeler Radojet intercondensers and centrifugal condensate pumps driven by 3-hp. General Electric Co. induction motors. All condensing equipment, including the circulating pumps, is of C. H. Wheeler manufacture. The circulating pumps all discharge into one header so that in case one of the pumps should develop trouble, the remaining pumps would continue to serve all condensers.

A feature of considerable interest to the electrical engineer is the fact that the main service pumps are driven by synchronous motors. This makes it possible to maintain the power factor almost at unity or slightly leading. The two service pumps are De Laval units, rated 2500 g.p.m., 155 ft. head at 1800 r.p.m. and are driven by General Electric 125 kv-a., 440-v. synchronous motors, each with its own exciter. A spare service pump is provided for Sunday operation. This is a Goulds pump driven by a 10-hp. Century Electric Co. motor.

Electrical Features

All current is generated and transmitted directly at 480 v., generation and distribution being controlled by a 15-panel General Electric switchboard. Views of this board are shown in Fig. 3. It is of the most approved standard design, incorporating all of the latest features of protection and control and was designed under the supervision of Alfred Mackay, the chief engineer and manager of the plant. Starting at the left-hand end, facing the board, the panels consist successively of a voltage regulator panel, an exciter panel, three generator panels and 10 feeder panels. Each feeder panel is provided with a receptacle and plug whereby the power factor of each feeder circuit can be determined individually. A power factor meter for the generators is also installed. The switchboard, as may be seen, is equipped with mechanically operated oil circuit breakers, mounted on an iron pipe framework about 6 ft. back of the board proper. The generator field rheostats are mounted above the switchboard structure. These are solenoid operated.

FIG. 9 THIS LOCOMOTIVE CRANE HANDLES COAL TO AND FROM STORAGE

The generators are equipped with reverse current relays for protection in case of failure to synchronize.

Conclusion

This plant has been in operation long enough to present operating difficulties but none have appeared, nor has any pitting shown up in boiler drums nor tubes. Judging from the care with which every detail has been worked out, and the close coördination maintained between the power plant and factory processes, it should produce power at an economical rate. The plant was designed entirely by Alfred Mackay, plant manager, with Clyde Price as assistant engineer. All details of the plant construction and design were worked out by them. The buildings were built by the Turner Construction Co., from plans by Clark MacMullin & Reilly, architects and engineers, New York.

Radiant Superheaters Find Wide Application

OVER 400 INSTALLATIONS PROVE UTILITY FOR PULVERIZED COAL AND STOKER FIRING WITH ALL TYPES OF BOILERS. POPULAR FOR INCREASING SUPERHEAT IN REBUILT BOILERS

RADIANT SUPERHEATERS, a relatively new development in power plant practice, came into prominence around 1919, about the same time that pulverized coal attained commercial importance in the power field.

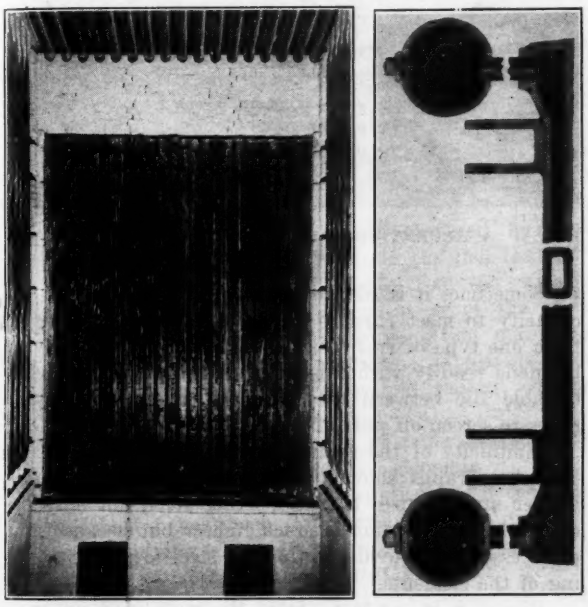


FIG. 1. FLAT FACED RADIANT SUPERHEATER AND SECTION OF ELEMENT. THIS IS THE CROCKER, BURBANK & CO. PLANT DESCRIBED ELSEWHERE IN THIS ISSUE

Both developments have been equally successful. Radiant superheaters have done much to help solve the problem of high superheat regulation and control and although they have lacked some of the publicity attending developments of other types of equipment, their use has progressed steadily until today one company alone reports something like 400 installations.

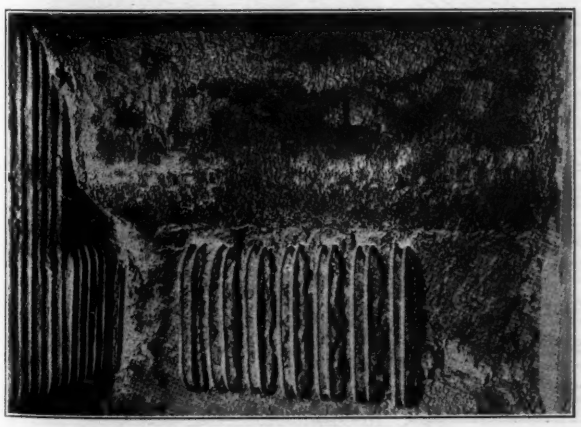


FIG. 2. ONE OF THE LATE TYPE RADIANT SUPERHEATERS MADE FROM 2-IN. TUBES

In the early designs, a complete element, consisting of cast-iron blocks shrunk on steel tubes, was used. Blocks were flat faced, with elements spaced on close centers so that a practically continuous flat face was exposed to the fire. Later, cast-iron elements were substituted for the composite elements and still later flat faced forged steel elements were introduced.

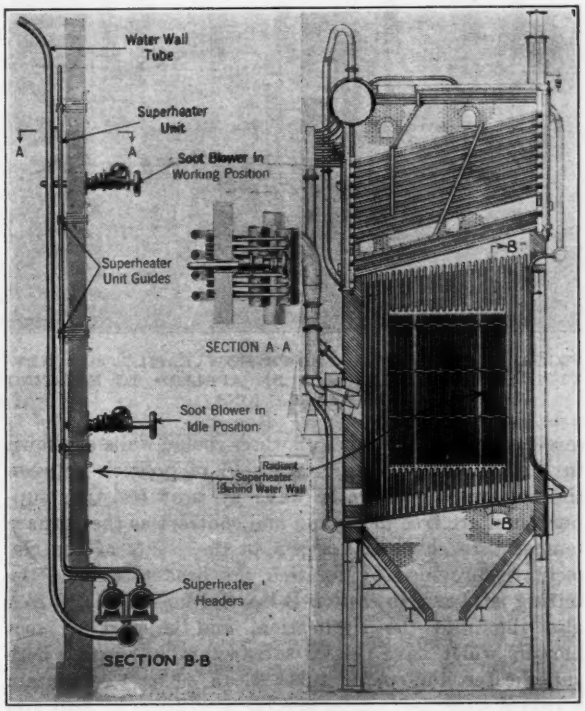


FIG. 3. ELEMENTS SCREENED BEHIND WATER WALLS. THE LEFT-HAND SECTION SHOWS THE SOOT BLOWER ELEMENTS

This later design was developed to a high state of perfection and widely used. Figure 1 shows a recent industrial installation (the Crocker, Burbank & Co. plant described elsewhere in this issue) where the radiant superheater covers practically the entire back wall of a pulverized coal fired furnace, and adds a superheat of 175 deg. F. to the 385-lb. steam output of the boiler.

Another type, a still later development which has many structural advantages, is shown in Fig. 2. Round tubes 2 in. in diameter and widely spaced from each other and from the furnace wall are used. The installation shown operates in parallel with a convection superheater, on a 225-lb., 750-hp. boiler, to give a superheat of 185 deg. at all ratings.

Sometimes these superheaters of this type are

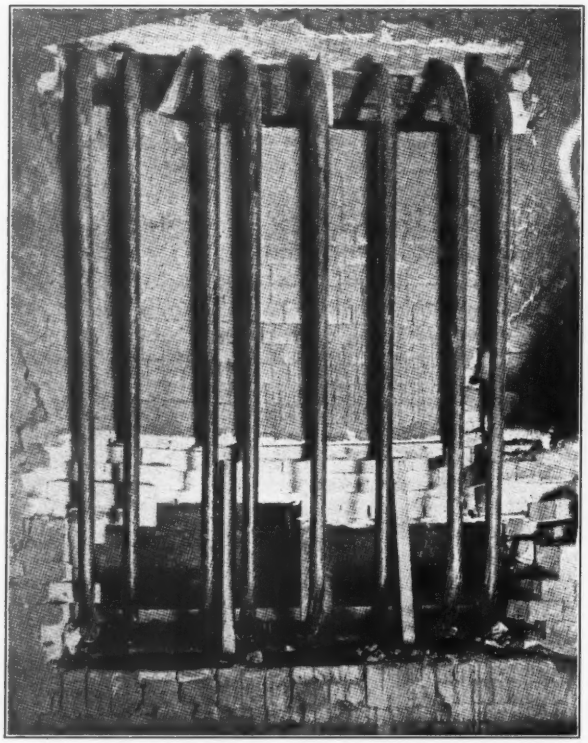


FIG. 4. THIS PICTURE SHOWS HOW EASILY THE NEW TYPE SUPERHEATERS MAY BE APPLIED TO EXISTING INSTALLATIONS

screened behind the tubes of water-cooled walls as shown in Fig. 3. Vertical units are held in position between the brickwork and water walls by heat resisting supports and are free to expand and contract as the furnace temperature changes. Access to the joints of the elements is provided by locating the headers outside the setting as shown in section B-B. Sections B-B and A-A also illustrate the application, and support of soot blowers which have proved satisfactory in keeping both superheater and water tubes clean so as to maintain constant superheat under similar conditions of load and combustion.

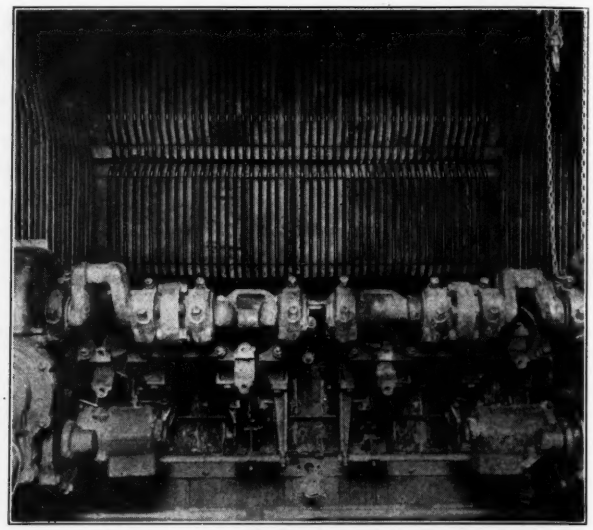


FIG. 5. A RECENT INSTALLATION IN A STOKER FIRED PLANT

Sometimes it is advisable to adjust the superheating capacity to meet furnace condition, as when changing from one type of fuel to another. This adjustment can be made readily with this type superheater by placing suitable tile between the superheater and water wall tubes to screen off part of the former.

Simplicity of the round tube type is apparent from the photographs shown. The tubular construction is lighter and requires less supporting steel, not only because the construction is much lighter but because it is unnecessary to provide reinforcing steel to prevent bowing of the elements.

Placed 8 in. or more from the walls and on wide centers, the tubes receive heat from all sides; radiation from the furnace in front and from the hot refractory wall in the back. In addition, a considerable amount of heat is transferred by convection from the hot gases passing near the walls.

When the elements are of considerable length they are sometimes supported at the center as shown in Fig. 5. Here the elements are sufficiently bowed in at the center

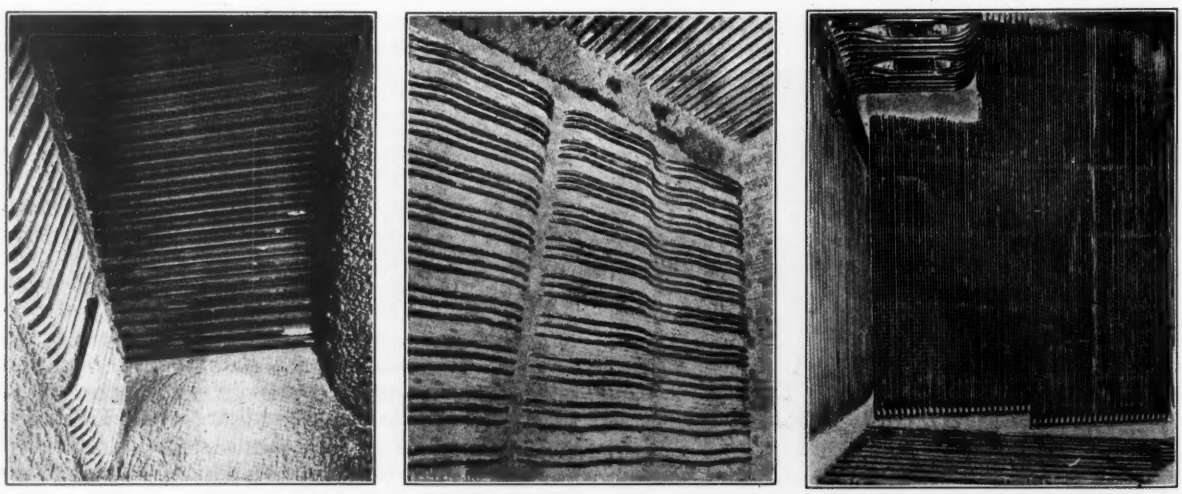


FIG. 6. A. BOOSTER SUPERHEATER TO INCREASE SUPERHEAT 100 DEG. F. B. SUPERHEATER USED ALONE TO GIVE 250 DEG. F. SUPERHEAT. C. SUPERHEATER FOR REHEATING IN A 1400-LB. BOILER

to bring them in contact with the brickwork at that point and so afford protection of the brick to the steel supports. This picture was taken before the front wall was installed and before the brickwork was installed behind the superheater, so that the steel supports are still visible. This particular installation, one of the latest, is under a new 1530-hp. boiler at Waterside Station of the Louisville Gas & Electric Co. The superheaters are designed to give 185 deg. of superheat at the normal boiler output of 90,000 lb. of steam per hr.

Some of the advantages of radiant superheaters may be summarized briefly as follows: a, high heat absorption per square foot of heating surface; b, impose no draft loss; c, accessibility for inspection, cleaning and repairs; d, reduce refractory maintenance; e, give a drooping superheat characteristic; e, can be used in series with convection superheaters to give a flat superheat characteristic; f, can easily be installed in old installations to increase the superheat to meet modern turbine requirements; g, can be used for reheating to eliminate a separate reheat boiler.

The flat characteristic curve obtained from combination superheaters results from the fact that as the boiler rating increases, superheat from the convection elements increases while superheat from the radiant elements decreases. A similar condition maintains a uniform superheat when combustion conditions change. Convection superheat increases and radiant superheat decreases with smaller amounts of CO_2. Uniformity of the superheat, under all loads, of course, depends upon proper proportioning of the two elements.

Perhaps the most popular application of the radiant superheater has been for boosting the superheat in existing plants, either to increase the superheat to take advantage of economies of high temperature with modern turbines or to maintain the superheat in boilers which have been rebuilt to give greater steam outputs. Ease of installation of the new type is well illustrated by Fig. 4, taken before any brick was replaced in the wall. This installation boosts the superheat 70 deg. in a 260-lb., 516-hp. boiler.

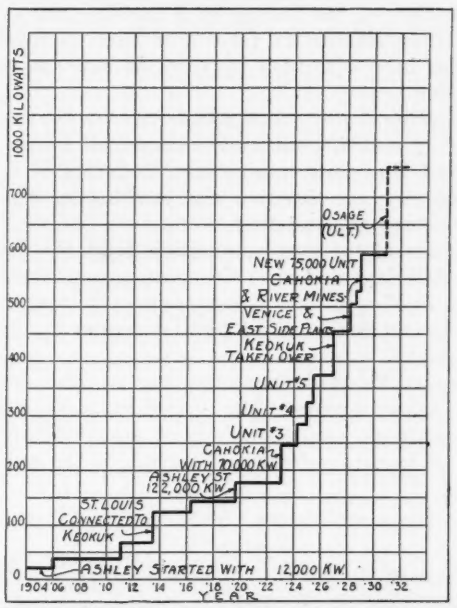
Flexibility and adaptability to local conditions are well illustrated by the accompanying photographs showing both pulverized coal and stoker fired furnaces. Oil or gas firing serves equally well. The location and application determine the preferable type. Tubular elements are generally preferred except for certain applications such as the side walls of stoker fired furnaces and certain marine furnaces where the flat faced steel elements have advantages.

Three different types and applications are shown in Fig. 6. The first photograph shows one of eight 1306-hp. boiler furnaces. Originally the boilers were equipped with convection superheaters. After several years, service it was found possible to use higher superheat with new turbines and the radiant superheaters were added to give an additional 100 deg. of superheat.

In the second picture are shown the horizontal radiant heat elements in 1765-hp., 300-lb. boiler at Lakeside Station. No convection superheaters are used and the radiant elements produce 250 deg. of superheat. The third picture shows one of the 1400-lb. boilers at Lakeside Station. This is half of the reheating unit and measures 22 ft. wide and 29 ft. high. The other half, or panel is on the opposite wall. This is a 2850-hp. bent tube boiler. A convection unit superheats the 1400-lb. steam and the reheater shown raises the temperature of the 250,000 lb. per hr. exhaust of high-pressure turbine at 350 lb. pressure to 750 deg. F. before it enters the low-pressure header. With this arrangement, no separate reheat boiler is required.

Keeping Step with St. Louis

GROWTH in rated generator capacity under control of the Union Electric Light & Power Co. since 1904 is shown graphically by the accompanying chart. Marked acceleration is shown since 1923; 92,500 kw. were added in 1929 and the completion of the Osage River development to its ultimate capacity will give a system capacity of over 750,000 kw.



GROWTH OF THE UNION ELECTRIC LIGHT & POWER CO.

One of the biggest accomplishments during the past year was the remodeling of four boilers at Cahokia to produce sufficient steam for a new 75,000-kw. unit which replaced a 35,000-kw. unit formerly supplied by the same four boilers. The 35,000-kw. unit was moved to Venice Station in record time. This unit is now supplied by steam from a 1950-hp. boiler, the largest in the St. Louis district.

HOT AIR is an effective drying agent, not because of the heat but because of the increased moisture capacity of warm air. Air has a definite moisture carrying capacity at each temperature and this moisture capacity is about doubled for each 20 deg. rise in temperature.

Air saturated with moisture at 60 deg. F. will hold, roughly, twice as much moisture if heated to 80 deg. F. To make a drying room effective, there must be a constant flow of air through and around the room and it should be brought in intimate contact with the drying goods.

The air should be heated just before it enters the drying room and if drying only is desired, the air is not usually returned to the heating coils, but new air is brought in. It is best to use an exhaust fan for circulating the air.

Turbo Versus Turbine Generator

SURVEY OF AMERICAN AND EUROPEAN MANUFACTURERS SEEMS TO FAVOR THE TERM "TURBO-GENERATOR" FOR THE COMPLETE UNIT "TURBINE GENERATOR" FOR THE ELECTRICAL END ONLY

FOR SOME TIME PAST, there has been no standard term to designate, as a unit, electrical generators driven by steam turbines. The widely used term turbo-generator, which is defined in Webster's dictionary as "a combining form for turbine, meaning: a, coupled directly to a driving turbine, as turbo-alternator (an alternator coupled directly to a driving turbine) turbo-blower, etc.; b, consisting of a turbine, as turbo-machine (a machine of the nature of a turbine) turbo-motor, etc." is not satisfactory for two or three manufacturers and has been discarded by them in favor of turbine generator.

Believing that the manufacturers were the ones most vitally interested, a survey was conducted among American and European turbine manufacturers as a means of clarifying the situation and establishing a more or less uniform nomenclature.

Results of the survey, compiled from the replies of eight American and nine European manufacturers, are shown briefly in the accompanying tabulation. The majority favor the use of turbo-generator to designate the complete unit.

Replies received from the various companies are given below, grouped into American and European manufacturers, each list arranged alphabetically. The letter of inquiry referred to is given at the end of the article.

AMERICAN BROWN BOVERI ELECTRIC CORP.,
CAMDEN, N. J.

"Relative to the subject matter of your letter, our interpretation of the term 'turbine-generator' is the electrical end of the machine or alternator, suitable for operation at high speed, i.e., for direct connection to a turbine. The combined unit we generally understand by the term 'turbine-generator unit' or 'turbo-generator unit.' This latter term is generally intended to cover a turbine and a generator."

ALLIS-CHALMERS CO.,
MILWAUKEE, WIS.

"We do not see any objection to the term 'turbo-generator' as it is generally understood to refer to a steam turbine-driven machine. On the other hand, 'turbine-generator' might be taken as applying to a generator driven by either a hydraulic or steam turbine. We suppose, to be more exact, it might be designated as a 'steam turbine-generator' or 'hydraulic turbine-generator' as the case may be, but we believe the term 'turbo-generator' would generally be understood as applying to a steam turbine-driven machine."

ELLIOTT CO.,
JEANNETTE, PA.

"We believe there is no standard usage for the term turbo-generator although we have settled the matter among ourselves in the turbine department of the Elliott Co. and our conception of the terms is just the opposite of that named in the second paragraph of your letter. In other words, we use the term 'turbo-generator' to mean the type of generator which is used with the turbine, and to us the term 'turbo-generator' means the generator only, whereas the term 'turbine-generator' means the complete unit including turbine and generator.

"It would be a blessing to get matters of this kind straightened out."

GENERAL ELECTRIC CO.,
SCHENECTADY, N. Y.

It is the General Electric Co.'s practice to speak of 'turbine generators' instead of 'turbo generators.' We cannot go into the fine points of grammar which cover this, but can merely tell you what our standard practice is."

MOORE STEAM TURBINE CORP.,
WELLSVILLE, N. Y.

"It is our practice to use the expression 'turbo-generator' rather than 'turbine-generator.' We presume that the expression 'turbine-generator' is probably used by parties who desire to make the expression similar to the expression 'engine-generator' which is in common use."

MURRAY IRON WORKS CO.,
BURLINGTON, IOWA

"Looking up the word in the dictionary, we find that the word 'turbo-generator' is the correct way to designate the combined unit. Some people may have an idea that the word 'turbo' was a commercially coined word. This may account for the tendency you mention, if such a tendency really does exist, to use the word 'turbine-generator' which, as you state, in reality means only the electrical end of the equipment. It is evident that the word 'turbo' is a well established prefix and the designation 'turbo-generator' is entirely correct and may be used without hesitation."

THE TERRY STEAM TURBINE CO.,
HARTFORD, CONN.

"We are aware that in some sections there is a tendency to use the term 'turbine-generator' rather than 'turbo-generator.' We here, however, have not followed this nomenclature. We feel that the terms 'turbo-generator unit' and 'turbo-alternator unit' are more satisfactory and at the same time more descriptive. The 'turbo-generator unit' is, of course, the direct current and the turbo alternator is the alternating-current machine."

WESTINGHOUSE ELECT. & MFG. CO.,
SOUTH PHILADELPHIA, PA.

"The Westinghouse Co.'s practice is to designate a complete unit, that is including turbine and generator, as a 'turbine-generator unit.' Mention is made of the generator alone as a 'generator.' 'Turbo-generator'

appears to be in the discard from what I can ascertain here."

FOREIGN MANUFACTURERS

Replies from foreign manufacturers were more uniform, indicating a unanimous preference for the prefix 'turbo' to designate high-speed steam turbine driver unit.

ALLEGEMEINE ELEKTRICITATS-GESELLSCHAFT, BERLIN, GERMANY

"Designations 'turbo-generator' and 'turbine-generator' are also employed in German literature interchangeably for designating the entire machine unit and for designating the electrical portion of the unit. We believe also that the consonance of both words in the English as well as in the German language is too great and that it would be worth recommending assignment to the two words a different meaning by definition. We practice this already in the intercourse of our offices, and use the words "turbo- or turbine-generator" without difference or distinction for the designation of electric generators; and designate the entire machine unit as "turbo-generator set."

BERGMANN-ELEKTRICITATS-WERKE, BERLIN, GERMANY
SPEAKING FOR THE
STEAM TURBINE MANUFACTURERS OF GERMANY

"This delay in answering your letter is due to the fact that we alone did not want to decide this question of the designation of a generator coupled direct or indirect to a steam turbine. We have, therefore, arranged a survey of our Association of Steam Turbine Manufacturers in Germany so that the associated members could also express themselves. The result of this inquiry is as follows:

"According to the general use of the language, the prefix 'turbo' serves to designate a high-speed type of a rotating machine, or rather its rotor. All machines denoted with the prefix 'turbo' designate a special design with small diameter at a comparatively great length and with circumferential speeds near the admissible limit.

"An essentially different meaning comes to the word 'turbine.' With it one designates a machine by the special manner of operation by which turbines distinguish themselves fundamentally from other machines. But the word 'turbine' does not indicate high speed and it cannot be changed to cover this because the rotative speed of turbines depends upon the physical properties of the operating medium used (steam, gases, liquids) being, therefore, quite different.

"The German Turbine Industry stands accordingly upon the standpoint that both designations shall remain side by side."

BROWN, BOVERI & CO.,
BADEN, SWITZERLAND

"We use the term 'turbo-generator' in two ways:

(1) as a generator coupled with a steam turbine, and

(2) as a generator running at high speed, that is to say, we call a generator 'turbo-generator' if it is designed to run at high speed.

"The term 'turbine-generator' is not known at all on the continent. We should therefore prefer the term 'turbo-generator' to 'turbine-generator' for the following reasons:

(1) of its general use up till now,

(2) of its meaning being internationally known,

(3) the expression being the same in several languages as German, English and French with the difference, that in French the designation is 'turbo-generatrice'."

THE ENGLISH ELECTRIC CO.,
RUGBY, ENGLAND

"We were obliged by your letter raising the rather vexed question of the title to be applied to a combined steam turbine and generator, and concurrently the title for the generator alone.

"The title 'turbo-generator' was first applied to the combined turbine and generator at a time when the

Manufacturer	To Designate Complete Unit		
	Turbo-Generator	Turbine-Generator	Turbo-Generator Unit
American Brown Boveri Elec.Corp.			✓
Allis-Chalmers Co.	✓		
Elliott Co.		✓	
General Electric Co.		✓	
Moore Steam Turbine Corp.	✓		
Murray Iron Works Co.	✓		
Terry Steam Turbine Co.			✓
Westinghouse Elec.& Mfg. Co.		✓	
Allegemeine Elektricitats-Gesellschaft			✓
Bergmann-Elektricitats-Werks (For the Assoc.of St.Turb. Mfg. of Germany)	✓		
Brown, Boveri & Co.	✓		
English Electric Co., Ltd.	✓		
Escher Wyss & Co.	✓		
Metropolitan-Vickers Elec.Co.	✓		
Siemens-Schuckertwerke, A.G.	✓		
N.V.Machinefabriek Gebr. Stork Co.		✓	
Svenska Turbinfabriks Aktiebolaget Ljungstrom	✓		

A SUMMARY OF THE PREFERENCE EXPRESSED BY A NUMBER OF MANUFACTURERS FOR DESIGNATION OF HIGH-SPEED STEAM TURBINES

makers of steam turbines were forced to manufacture their own generators because no suitable generators could be bought elsewhere. After a time, other electrical manufacturers began to produce generators suitable for coupling to steam turbines, and these electrical manufacturers in some cases applied the combination word 'turbo-generator' to the generators alone. We believe they had no warrant to do so outside their own organizations as, among users of steam turbine plant, the title 'turbo-generator' still meant the combined steam turbine and generator.

"In our opinion, it would be useful to have it laid down definitely that the combined word 'turbo-generator' applies to the steam turbine and the generator driven thereby.

"It is a little more difficult to get a good title for the generator itself, and in this country we think that the words 'high-speed generator' have often been used. The title 'turbine type generator' has also been used and as this is cumbersome we are inclined to think your suggestion to use the term 'turbine generator' for the generator itself is a good one. Possibly the only objection may be the similarity of these two words to the combination word 'turbo-generator' and it might therefore be well to lay it down that the full title of a turbine-driven generator shall be 'turbine type generator' but that for ordinary use this can be abbreviated to 'turbine generator.'

"We are writing this letter on our own responsibility only but would suggest that if the matter is to be settled it would be desirable for the English speaking peoples to fix on a common terminology."

ESCHER WYSS & CO.,
ZURICH, SWITZERLAND

"In reply to your letter, we would state that here in Switzerland and in other countries to which we supply steam turbines, the designation 'turbo-generator' is mostly given to a steam turbine generator set. The designation 'turbine-generator' is never used. We think that the latter could just as well describe a water turbine with generator and thus lead to misunderstanding, whilst the word 'turbo' is used by us exclusively to describe a set with steam turbine drive. In view of the foregoing, we should prefer the word 'turbo-generator' to be retained."

METROPOLITAN-VICKERS ELECTRICAL CO.,
MANCHESTER, ENGLAND

"Replying to your communication, we would say that we agree with the argument in your letter. We refer to a combined unit of turbine and generator as a 'turbo-generator.'

"Further, we would understand the term 'turbine-generator' to designate a generator of the turbine or high-speed type."

SIEMENS-SCHUCKERTWERKE, A. G.,
BERLIN, GERMANY

"Your letter has been circulated among the members of the Association of the German Electro-Technical Industry (Zentralverband der Deutschen Elektro-Technischen Industrie) and of the Association of Steam Engine Manufacturers and Designers (Verein Deutscher Maschinenbau-Anstalten), but no uniform proposal has come forward.

"In the German language, the expressions commonly used are: first, for the combined steam turbine and electrical generator:—'turbo-satz,' which is generally translated into English as: 'turbo-set,' or second, for the electrical generator alone the expression 'turbo-generator' is used, translated into English as, 'turbo-generator' or 'turbo-alternator.'

The expression 'turbo-generator,'' however, is also frequently used in German for the combined set, probably on account of the English technical literature where this expression is almost universally found.

"We would therefore propose not to make a change and leave it as 'turbo-generator.'

N. V. MACHINEFABRIEK GEBR. STORK & CO.,
HENGELO, HOLLAND

"Up to the present, we designate the entire unit with the term of 'turbo-generator.' Our firm being the sole builders of steam turbines for electricity works in Holland, we do not know which term other firms use. As far as we know, however, a manufacturer of electrical engines (also the only one in Holland) designates generators running with more than 1500 r.p.m. with the term of 'turbo-generator,' in which case only the electrical engine is meant.

"For this reason, it would, of course, be desirable to choose for the entire unit (turbine and generator) another term, e.g., 'turbine-generator.'

"We shall be glad to learn which term the various manufacturers of steam turbines wish to accept for the entire unit, which we will likewise adopt."

SVENSKA TURBINFABRIKS AKTIEBOLAGET LJUNGSTROM,
FINSPONG, SWEDEN

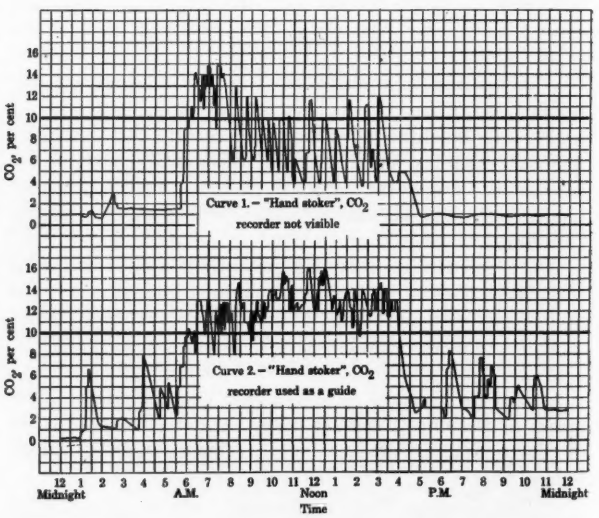
"We have the pleasure of informing you that we are and have always been using the term 'turbo-generator' to designate the power generating set consisting of steam turbine direct coupled to an alternator. We believe that this term is the correct one."

Letters to the various manufacturers were as follows:

"For some time past, we have noticed a tendency for some turbine manufacturers to use the designation 'turbine-generator' rather than 'turbo-generator' to designate units where the electric generator is direct connected to the steam turbine and, we suppose, in cases where the generator is driven through gears. The designation 'turbine generator' is, of course, the only logical way to designate the generator built especially for steam turbine drives, but it does seem that from usage and the definition given in Webster's dictionary, "turbo-generator' is the more logical method of designating the entire unit. We would appreciate your advice as to whether you consider this change advisable."

How Valuable Are Instruments?

EVIDENCE necessary to prove that instruments do increase the operating efficiency of a plant is not always available or, if available, it is not always authentic. The accompanying curves made by J. F. Barkley of the Bureau of Mines, in Serial 2946, entitled "Some operating results on small heating plant stokers" should furnish ammunition to engineers who have to fight for equipment and prove that expenditures will earn a good return.


CO_2 per cent
Curve 1.—"Hand stoker", CO_2 recorder not visible
Curve 2.—"Hand stoker", CO_2 recorder used as a guide
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
Midnight
A.M.
Noon
P.M.
Midnight
Time

Curve 1 shows a typical record of the CO_2 variations when the CO_2 recorder could not be observed by the fireman while Curve 2 shows the improvement with the CO_2 recorder used as a guide by the fireman. Practically no CO was produced even at CO_2 percentages as high as 15 per cent. Combustible in the refuse generally runs around 35 to 45 per cent.

Power Plant Materials-Handling Tools—II

Skip Hoists, Automatic Loading, Cleaning and Distributing Coal. By W. W. Sayers

SHOULD the supply track be located alongside or at one end of the boiler house, the skip hoist is well suited to elevate the coal and dump it into the overhead bin direct, or onto a belt or flight conveyor for distribution to a long overhead bunker. The skip hoist, Fig. 6, is a tool admirably suited for elevating the coal from the crusher and dumping it into a hopper for distribution to the overhead bunker, since the skip is hoisted vertically, or at a slight inclination, therefore requiring but a minimum of space. It has the additional advantages of being adapted to high lifts and to large or small tonnage capacities per hour.

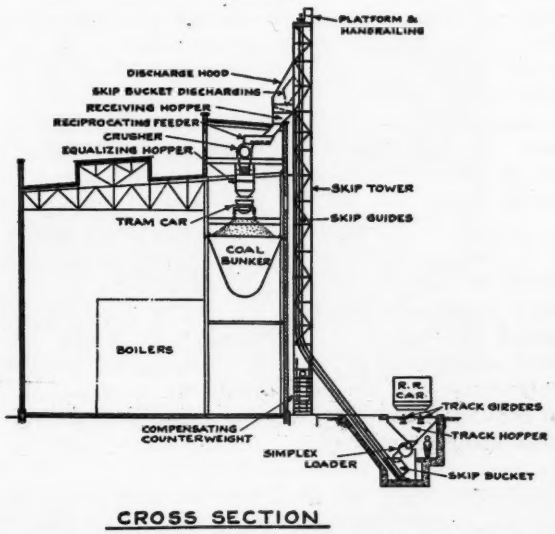


FIG. 6. BEAUMONT SKIP HOIST EQUIPMENT FOR COAL AND ASH HANDLING AT ST. ANNE PAPER CO.

The skip hoist consists of comparatively few parts—the bucket, skip sheaves, hoisting rope, hoisting machine and motor assembled in a compact unit, a panel on which are mounted the electrical instruments for controlling the raising and lowering of the bucket and an automatic loader to fill the bucket properly. Electrical control instruments, over-travel limit switches, slack cable device and its switch, traveling cam limit switch, solenoid brake and the motor driving the hoisting machine are connected in such a manner as to insure reliable operation.

The hoisting machine consists of a large drum, on which the bucket and counterweight cables are wound and unwound and which is mounted on a heavy shaft, driven through reduction gears by the motor. The highest-grade hoisting machines have herringbone reduction gears, antifriction bearings for all shafts, a housing supporting the shaft bearings and forming an oil-tight enclosure for gears, shafts and bearings, which are automatically lubricated by an oil bath as the gears revolve. The gear housing and the sub-base are made in one compact rigid steel unit, upon which are mounted the outboard bearing of the drum shaft, the solenoid brake, the traveling cam limit switch and the motor.

Skip Hoist Loaders

To load the skip or bucket properly, the automatic loader is provided, of one of three principal types.

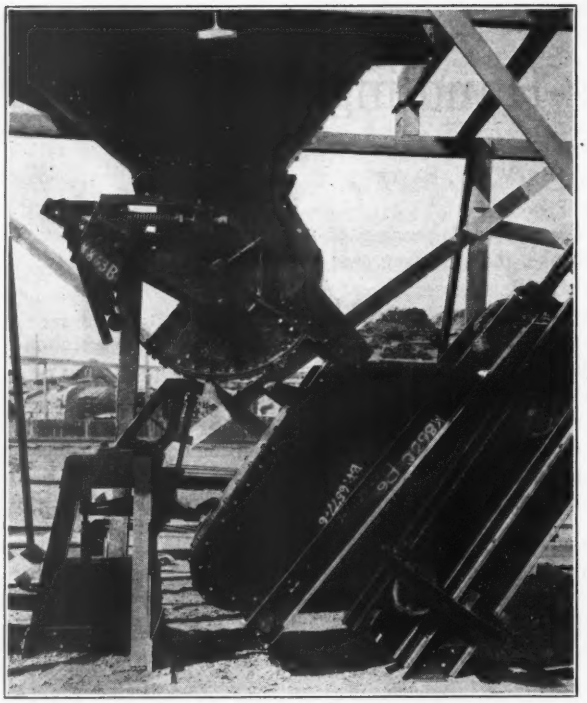
The damming type consists of a gate and chute attached to the bottom of the track hopper. It is in the up or closed position, except when the descending bucket lowers the chute and opens the gate, which allows material to discharge into the bucket until it is full, the material then damming up in the chute and stopping the flow. As the filled bucket is hoisted, the chute swings to its up or closed position, at the same time closing the gate, which is a part of the chute. This loader functions well but requires a fixed time period for the loading operation and permits the bucket to be hoisted when there is no material in the hopper to fill the bucket.

POWER HOE AND LINK-BELT SKIP HOIST, 50 T. PER HR. IN COAL STORAGE YARD

The weight-of-material-in-bucket type, Fig. 7, has a chute, a gate and mechanism for automatically closing the gate when a predetermined weight of material has been delivered into the bucket.

In the operation of this skip hoist, the descending bucket opens the gate on the loading hopper and comes to rest on a counterweighted lever. The material immediately starts to flow into the bucket and continues to flow until the weight of the material is sufficient to overcome the counterweight.

Then the beam on which the bucket rests drops slightly and permits the gate to close, which cuts off the flow of material into the bucket and releases the starting interlock. Current now passes to the hoisting



NO. 7. AUTOMATIC LOADER OF WEIGHT TYPE, C. O. BARTLETT & SNOW CO.

engine motor and the bucket immediately starts its upward travel.

Electrical control equipment accelerates the bucket to full speed, slows it down when it approaches the dumping position, holds the bucket in position for a clean discharge, then reverses the hoisting engine and returns the bucket to the loading position. The same cycle is then repeated.

When no more material is in the hopper, the hoist automatically stops but, just as soon as material is again dropped into the hopper, the hoist automatically resumes its operation. In short, this equipment starts itself as soon as material is dropped into the hopper, continues to operate as long as there is material to lift and then automatically stops. The bucket cannot start until it has a full load, so that each trip it carries the same weight of material.

The full bucket control type of automatic loader, Fig. 8, is of new and original design, consequently of unusual interest to skip hoist users. This loader is the same in construction as the damming type, but is quite different in operation, as the bucket remains stationary until it is fully loaded and is hoisted as soon as it has been filled. In other words, the equipment operates only when there is sufficient material in the hopper to fill the bucket. Inside or outside of the loader chute a simple yet rugged hinged plate is hung. When the flowing material completely fills the bucket, it swings the plate and closes a switch, which causes the bucket to be hoisted instantly.

This loader is simple, yet effective in governing the hoisting operation by full loading.

Few designers have made the mistake of providing too much overhead storage for coal ready to be delivered to the stokers. Many have made the error of having insufficient storage capacity to allow for delays in receipt of shipments, thus necessitating S. O. S. messages by the operating department.

For the quite small plant, requiring a few tons a day, accommodations should be for at least two days' consumption, plus a full car load. The reason is obvious.

The medium size plant should have two days' maximum supply overhead storage and an auxiliary ground storage supply for one or two weeks' requirements adjacent to the boiler house, which can be drawn upon immediately in case of delayed shipments or bad weather. If it is impossible to provide an auxiliary storage, the overhead bunker capacity should hold at least one full week's supply.

The large or super boiler plant burns such enormous amounts of coal that it is seldom practicable to provide more than 24 hr. overhead storage and sometimes even less. These plants, however, always provide a secondary storage adjacent to the boiler house, from which they can quickly and economically draw enough for their daily requirements, to insure uninterrupted operation. They usually have secondary ground storage, sufficient to take care of one or more months' operation, equipped with cranes, bridge tramways, or drag scrapers, for economically storing and reclaiming large tonnages per hour. A large auxiliary storage permits purchasing coal at favorable prices, in addition to insuring a desirable quality and quantity of coal at all times.

Ordinarily, the overhead storage is locately in front of the boilers but there are conditions where it is desirable to place it centrally with or at one end of the boiler house and distribute the coal to the stokers as needed, by means of a traveling weigh larry. This latter arrangement is necessary where stokers, overhead storage and coal handling equipment are installed in an existing boiler plant, to avoid remodeling the boiler house building and roof.

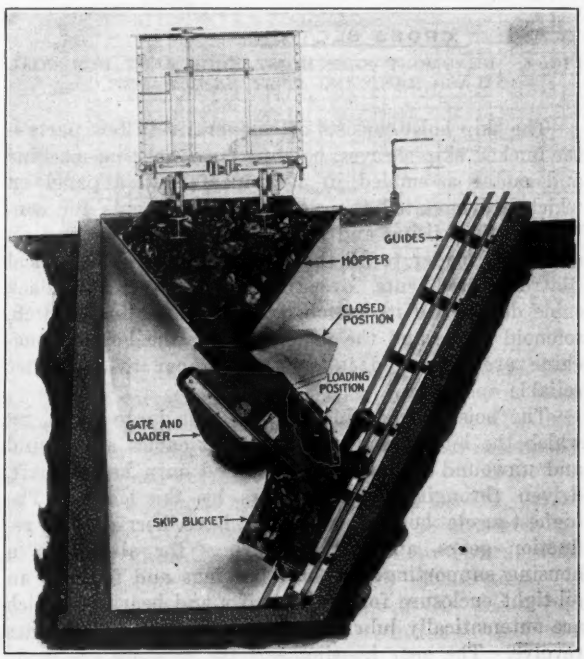


FIG. 8. FULL-BUCKET-CONTROL AUTOMATIC LOADER

Coal Weighing Tools

Track scales serve to weigh and check carload shipments as they are received for unloading to either overhead or ground storage.

Weightometers are used to weigh and record automatically the weight of coal passing over the conveyors on which they are installed, before the coal is discharged to the bunker. The weightometer provides an accurate record of all coal delivered to the bunkers, practically eliminating the human element.

Weigh larries, Fig. 10, are located under the overhead storage bunker to permit drawing the coal from storage into the larry hopper, for weighing and transferring to the different stokers as needed, the larry traveling on overhead tracks in front of the boilers and under the bunker. The weigh larry accomplishes the following desirable results: Transfers the coal from overhead storage to stokers; weighs and records the total amount of coal drawn from the overhead bunker;

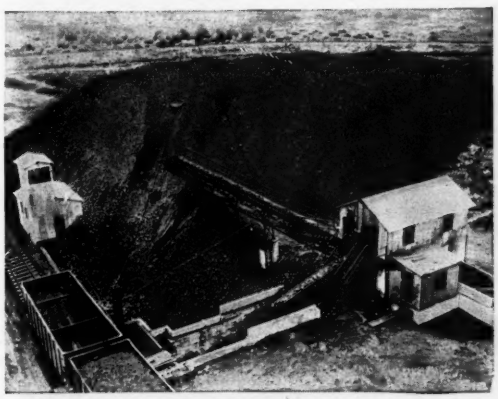


FIG. 9. STORAGE YARD WITH SAUERMAN SCRAPER SYSTEM FOR STORING AND RECLAIMING COAL

weighs and records the total amount of coal delivered to each stoker; transfers coal from any part of overhead storage to any stoker, thus avoiding dead or unusable overhead storage over boilers which are not in operation.

Weigh larries vary in capacity from 1000 to 20,000 lb. or more, depending upon the size of plant, the length of travel and the number of boilers served.

When the boilers are fired with pulverized fuel, automatic coal scales may be introduced between the coal bunker and each boiler, thus obtaining an accurate record of the amount of coal burned by each boiler.

Foreign Substance Removal Tools

Coal, as received, is bound to contain blocks of wood, timbers, coupling knuckles, links and pins, mining machine cutter bits and other refuse. Unless these are removed, they are likely to damage subsequent handling tools seriously, therefore, means are provided to get them out. Frequently, an attendant is supposed to watch for injurious material, as the coal flows from the car, and remove it. Unfortunately, man is an independable tool for many purposes and is, therefore, unsatisfactory.

Hammer and ring mills have effective arrangements for catching and removing tramp-iron, or other materials that will not pass through their cages. The Bradford breaker prevents the larger pieces from passing through its perforations and reaching the bunkers. Apron feeder conveyors may be provided with magnets at their discharge end, to remove tramp-iron of all kinds and prevent its reaching and injuring the crusher.

When coal is to be pulverized, it is especially important to remove all iron before it can reach the fine pulverizers. This is done by installing, on a belt conveyor over which the coal passes, a magnetic pulley, which will effectively remove the iron.

Ash Handling Tools

Ash is an undesirable and unwelcome product of combustion. It represents loss in fuel value, loss in freight and previous handling and still further loss in having to provide equipment to handle, to store and to dispose of it. Ashes will always be with us, hence may as well be cheerfully accepted and handled with efficiency and dispatch. A survey of ash handling tools discloses quite a variety of equipment for that purpose.

Where a small amount of ash is to be handled, the wheelbarrow and shovel still hold first place. When the ash must be elevated and discharged at street level into wagons, or into a small overhead bin, the ash lift and centrifugal discharge elevator serve the purpose and require minimum investment. Frequently portable belt conveyors or elevators are advantageously used to load piles of ashes into wagons or trucks.

For conveying and elevating the ash and discharging it into an overhead bin, the steam jet is especially well adapted where the ash must travel a tortuous path and where there is little space for other types of equipment. This system requires considerable steam, if the quantity of ashes hoisted is large, also the abrasive quality of ashes tends to wear out turns and pipes, unless specially reinforced.

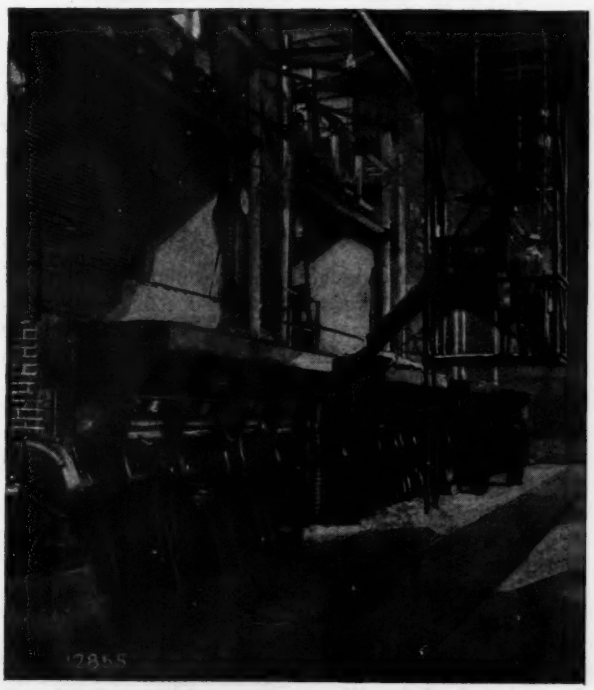


FIG. 10. COAL SUPPLIED TO STOKER HOPPERS BY JEFFREY WEIGH LARRY

If the ashes can be handled in the same equipment that is used for handling the coal, the overlapping pivoted bucket (described under coal handling tools) makes an efficient and satisfactory installation. The skip hoist is the best ash handling tool, when the quantity is large enough to warrant the necessary investment and when separate ash handling equipment is required or advisable. Frequently the ashes are drawn from pits or hoppers into industrial cars, which are pushed along a track and dumped into the skip bucket for hoisting and dumping. As the skip bucket is suited for handling large clinkers, small ash or soot, it is commonly used for them, as well as for the coal. The equipment is the same as for coal except that the automatic loader is seldom used.

Large boilers produce large quantities of ash, hence are often provided with big cast-iron ash hoppers and gates lined with tile; also with clinker chambers, clinker grinders, sluiceways, nozzles and pumps; or they may

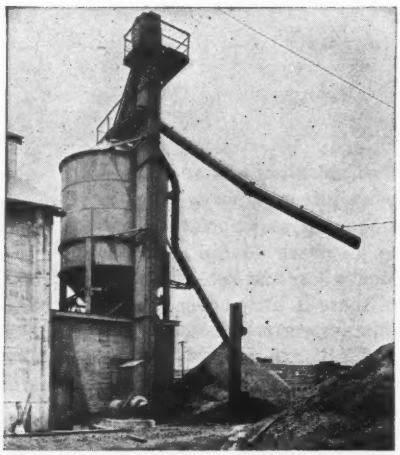


FIG. 11. WEBSTER-WELLER STEEL STORAGE BIN

have railroad tracks located under the ash hoppers, so that the ashes may be emptied directly into railroad cars. Ash storage bins of concrete, of cast iron sections, or of steel lined with tile, brick or concrete are employed for storage until a sufficient quantity has accumulated to be drawn into the railroad cars or trucks, Fig. 11.

More Thought Needed About Coal and Ash Handling

In the past, the design of power plants has largely been dominated by the electrical and combustion engineers, whose aim was to generate a horsepower or kilowatt with a minimum of coal and steam. All too frequently the importance of and the saving that could be made in, the handling of the condenser water, or in unloading, storing, preparing, conveying and distributing the coal to the bunkers and in the handling of the ashes, has been given less careful consideration.

Equipment for handling these bulk materials is no less important than the steam or electrical generating equipment, as the fuel must be handled and prepared before the boiler or generator can produce steam or electricity.

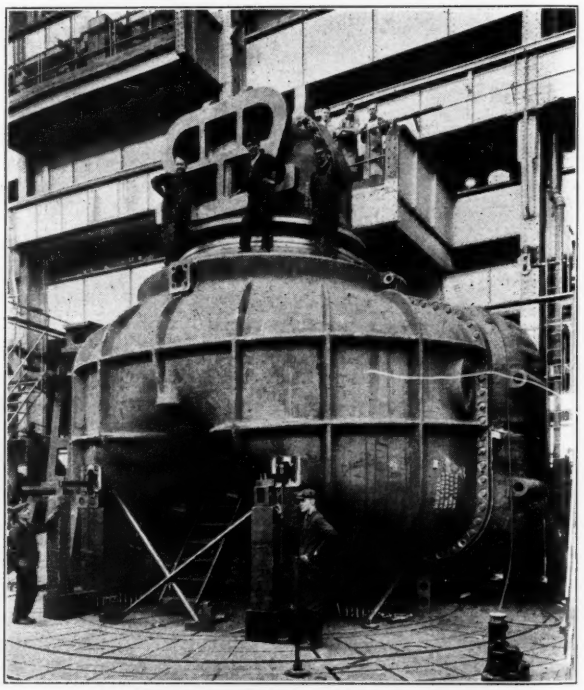
Power plants with the best steam and electrical equipment, provided with reserve units are often served by coal and ash handling equipment which was selected and purchased on a price basis with the feeling that, "Anything is good enough;" "There is no use providing duplicate equipment as is done for the boilers or generators or to provide reserve handling capacity;" "One type of equipment is just as suitable as another so let them crowd the coal and ash handling equipment into whatever space is left."

Some engineers have appreciated the importance of the bulk material handling tools, have made ample provision for them and have selected them with care. Many others have not.

Coal, ashes and water-handling tools are to be had, which are just as highly developed and efficient for their intended purpose as the steam boiler, the stoker, and the turbine generator; and their selection and application should be given due consideration, as every tool is best suited for certain conditions and no tool is applicable for every condition.

Buffalo to Have 75,000-Kw. Unit

Head, shell and exhaust hood of a large turbine for the Buffalo General Electric Co. are shown being



SHOP VIEW OF 75,000-KW. UNIT

machined on a boring mill at the Schenectady Works of the General Electric Co. The turbine is designed to produce 75,000 kw. of 25-cycle electricity at 1500 r.p.m. It is designed for steam conditions of 250 lb. gage, 250 deg. superheat, and one inch absolute back pressure.

Outside packed plunger pumps are favored for pumping gritty water and for high pressures because the condition of the packing can be determined at a glance, slip or leakage cannot take undetected and the pump is easier to repack than a piston pump. On the other hand, they require more floor space and more power than a piston pump of the same capacity.

Power from Process and Space Heating Steam

PART III. WHEN USING EXTRACTION TURBINES, HOT WATER HEATING OFFERS SOME ADVANTAGES OVER STEAM HEATING. BY L. A. HARDING*

WHEN TURBINE EXHAUST steam is to be employed for space heating, considerably more electrical power may be generated with a hot water system than with a vacuum steam system on account of the fact that a lower back pressure may be carried at the turbine as will be evident by the following example.

STEAM SYSTEM

Assume a heating load of 100,000 sq. ft. of equivalent direct steam radiation equivalent to 24,276,000 B.t.u. per hr. or 24,276 lb. of steam per hr. (latent heat assumed as 1000 B.t.u. per lb.). Initial steam pressure 200 lb. abs., no superheat and 20 lb. abs. (5 lb.g.) back pressure.

*President, L. A. Harding Construction Co., Buffalo, N. Y. From a paper presented before the A.S.H. & V.E. Part I appeared in the March 1, 1930 issue, p. 277 and Part II in the April 1, 1930 issue, p. 384.

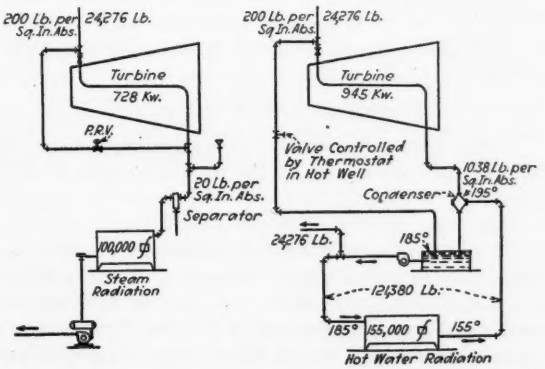


FIG. 1. DIAGRAMMATIC REPRESENTATION OF STEAM AND HOT-WATER HEATING SYSTEM ARRANGEMENTS

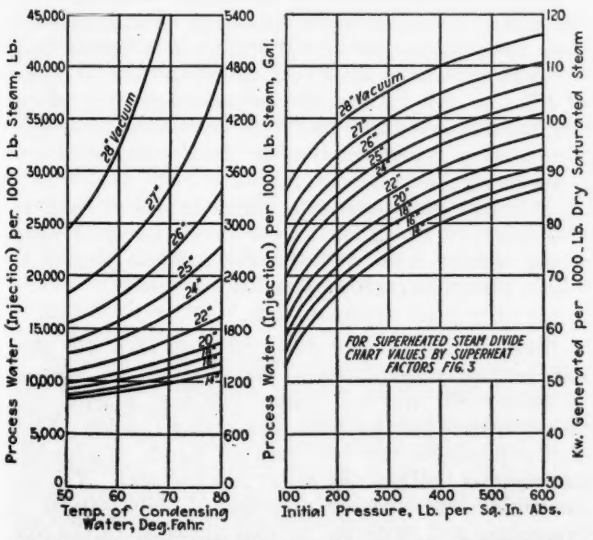

Process Water (Injection) per 1000 Lb. Steam, Lb.
Temp. of Condensing Water, Deg. Fahr.
Process Water (Injection) per 1000 Lb. Steam, Gal.
Initial Pressure, Lb. per Sq. In. Abs.
Kw. Generated per 1000 Lb. Dry Saturated Steam
28" Vacuum
FOR SUPERHEATED STEAM DIVIDE CHART VALUES BY SUPERHEAT FACTORS FIG. 3

FIG. 2. CHARTS SHOWING THE POWER GENERATED AND WATER HEATED PER 1000 LB. OF SATURATED STEAM

Ideal water rate for the turbine is 20 lb. per kw-hr. The expected water rate for an assumed combined efficiency of turbine and generator of 60 per cent is 20 ÷ 0.60 = 33.3 lb. per kw-hr. The power that could be generated with the vacuum steam system is therefore 24,276 ÷ 33.3 = 728 kw.

HOT WATER SYSTEM

Assuming an initial water temperature of 185 deg. and final temperature of 165 deg. for the radiation, the amount of water to be circulated is: 24,276,000 ÷ (185 — 165) = 1,213,800 lb. per hr.

Initial temperature of the injection water will be 165 deg. and the final temperature 185 deg. The steam temperature for a 10-deg. terminal difference is 185 + 10 or 195 deg. corresponding to an absolute pressure of 10.38 lb. per sq. in. Assuming a combined efficiency of generator and turbine of 63 per cent, the expected water rate is 16.2 ÷ 0.63 = 25.7 lb. per kw-hr. Power that could be generated for the assumed conditions is, 24,276 ÷ 25.7 = 945 kw.

Increased power that could be developed is, 945 — 728 = 217 kw. or a gain of approximately 30 per cent

APPROXIMATE FULL LOAD EFFICIENCIES OF MULTI-STAGE GEARED TURBINE AND GENERATOR UNITS

Rated Cap'y. at Full Load kw.	Brake Potential Efficiency Ratio of Turbine ϕ_t (1)	Generator Efficiency at Full Load ϕ_g (2)	Combined Efficiency at Full Load $\phi_t \times \phi_g$ (3)
	NON-CONDENSING TURBINES		
100	0.47	.....	.....
200	0.48	.....	.....
300	0.61	.....	.....
400	0.63	.....	.....
500	0.64	0.940	0.600
600	0.64	0.942	0.603
750	0.65	0.944	0.614
1000	0.67	0.945	0.633
1250	0.67	0.947	0.634
1500	0.67	0.950	0.637
2000	0.68	0.954	0.649
	CONDENSING TURBINES		
500	0.68	0.940	0.639
600	0.69	0.942	0.650
750	0.70	0.944	0.661
1000	0.70	0.945	0.662
1250	0.70	0.947	0.663
1500	0.70	0.950	0.665
2000	0.70	0.954	0.668

1. Ratio $\frac{\text{Ideal Water Rate}}{\text{Actual Water Rate}}$ includes efficiency of gears.

Turbines of the re-entry type are somewhat less efficient than the values given in table for turbines 500 k.w. capacity and above.

2. 60 cycle—3600 r.p.m.

in power with the hot water system. This gain would be somewhat reduced if a sufficiently large vacuum pump were supplied for the steam system further to reduce the back pressure at the turbine.

The diagram on the right of Fig. 2 gives the kilowatts generated per thousand pound of dry saturated steam supplied to the turbine at various initial and terminal pressures. When the steam is initially superheated, divide the values as determined by a superheat factor (see Fig. 2, Part I). The expected power per 1000 lb. of steam is determined by multiplying the diagram values (corrected for superheat if any) by the combined efficiency of the turbine and generator, taken from the accompanying table.

Water which can be heated per 1000 lb. of steam supplied, which is also equal to the amount of injection water required at a temperature of 10 deg. less (terminal difference) than the temperature corresponding to the partial vacuum, may be read direct from the left hand chart of Fig. 2. (See Fig. 2, Part I for temperature—partial vacuum diagram.) The heat to be extracted per pound of exhaust steam is here assumed constant at 1000 B.t.u., a fair average value when superheated steam is supplied to the turbine.

Determination of Phosphate in Boiler Water

Simple Method of N. E. L. A. Committee Gives Results with a Possible Error of 10 Per Cent

IN BOILER WATER treatment, it is often advisable to use phosphate for treating the water. In order to control the use of phosphate, it is also advisable to be able to determine rapidly and with a fair degree of accuracy, the soluble phosphate in the boiler water at frequent intervals. The application of this method is intended for use on boiler water samples although if organic matter is present in sufficient amounts to cause a marked coloration of the water, this method cannot be used.

The test is dependent upon the fact that molybdenum present as phospholybdic acid may be reduced in the presence of an excess of molybdic acid. The reducing agent used is hydroquinone. If hydroquinone is added to an acid solution of molybdic acid, no phosphate being present, the solution will be colorless when treated with alkaline sulphite; but if phosphate is present, phospholybdic acid is formed and reduced giving a blue color. As small an amount as 5 p.p.m. of phosphate gives a distinct blue color in this test.

Apparatus and Solutions

1. Glass funnels and filter paper.
2. Three 250 c.c. volumetric flasks.
3. 10 c.c. and 5 c.c. pipettes.
4. 50 c.c. graduated cylinder.

Molybdic Acid Solution

This solution is made from 125 grams of pure ammonium molybdate dissolved without heat in about 2 liters of phosphate-free distilled water to which 75 c.c. of sulphuric acid (H_2SO_4) are slowly added and the volume made up to, roughly 2½ liters. A slight blue coloration does not hinder the use of this solution.

Hydroquinone Solution

To prepare this solution 50 grams of pure hydroquinone are dissolved in about 2½ liters of phosphate-free distilled water and 3 c.c. of concentrated sulphuric acid (H_2SO_4) added.

Carbonite-Sulphite Solution

To 6 liters of distilled water add 1500 grams of commercial soda ash. Dissolve 225 grams of sodium sulphite in 1500 c.c. of water and add to the soda ash solution.

Stock Solution of Phosphate

Pure mono-potassium phosphate is finely ground, dried at 105 deg. cent. for three hours, cooled and kept in desiccator. Of this salt 0.1432 grams are dissolved in distilled water, 5 c.c. of concentrated sulphuric acid (H_2SO_4) added and made up to one liter in a volumetric flask with distilled water. One cubic centimeter of this solution contains one-tenth of a milligram of phosphate (PO_4).

Sulphuric Acid Solution

Sulphuric acid solution mentioned later is made by adding 300 c.c. of concentrated sulphuric acid (H_2SO_4) to about 2200 c.c. of distilled water. This is labeled H_2SO_4.

Determination of Phosphate

Three 250-c.c. volumetric flasks are required. Into the first, measure 50 c.c. of the filtered sample of boiler water. By a pipette, 10 c.c. of the standard phosphate solution are delivered into the second flask and 20 c.c. of the phosphate solution are delivered into the third flask. Add to each flask in succession, 10 c.c. sulphuric acid, 5 c.c. of molybdic acid and 5 c.c. of hydroquinone solution. Allow the reactions to proceed for 5 min. then add to each flask 15 c.c. of the carbonate sulphite solution, agitate each flask to mix the reagents and fill each flask to the 250 c.c. mark with distilled water.

Place the flask containing the sample of boiler water between the two flasks containing the standard solutions and compare colors. If the color is lighter than the flask containing the 10 c.c., it is less than 20 p.p.m. of PO_4. If it is between the one containing the 10 c.c. and the one containing 20 c.c., it is between 20 and 40 p.p.m. If it is darker than the one containing 20 c.c., it is over 40 p.p.m.

Different maximum and minimum values may be established by changing the amount of standard phosphate solution used and the PO_4 content should be within a possible error of about 10 per cent.

Electric light and power utilities plan for 1930 total capital expenditures of $865,000,000, an increase of $65,000,000 over last year. The first quarter contracts indicate good progress in carrying this out. Electricity produced the first half of March exceeds the same period last year by about two per cent. The gas companies' construction program of $400,000,000 is proceeding and, with the portion allocated to the first quarter likely to be exceeded, will equal or exceed 1929.

Control Equipment for Synchronous Motors

Part III. Further Description of Various Types of Semi Automatic and Full Automatic Starting Panels.

By C. P. ROBINSON
Ideal Electric & Mfg. Co.

CONTINUING OUR DESCRIPTION of various types of starting panels, we will take up next the Semi-Automatic Reduced Voltage Starting Panels. The equipment supplied for this type of starter may be the same as for the semi-automatic full voltage starters except for main line switching equipment.

As in the case of the manually-operated reduced voltage starter, a standard compensator with start and run contacts may be used or oil switches together with an auto-transformer, resistance bank or other source for obtaining reduced voltage.

With this type of starter, the sequence of operation is essentially the same as in the case of the semi-automatic full voltage starter, except that the operator is required to perform one additional function, that of closing the running switch after the starting switch has been released.

General Application

The semi-automatic reduced voltage starter is especially popular in connection with medium and high-speed synchronous motors where inrush currents require reduced voltage starting. Synchronous motors from 514 r.p.m. up in speeds 200 hp. and below, fall into that class of synchronous motors designated as "Industrial Type," for general purpose application. Within this range, the above type of starter is most used. There are probably more variations in the general appearance and construction of starters under this classification, as listed by different manufacturers than occur in any of the other standard types of starters.

Figure 1 shows one type of Ideal semi-automatic reduced voltage starter. The compensator is enclosed in the cabinet below while above on the slate panel are mounted the timing relay, automatic field contactor, rheostat handle and meters.

Figure 2 shows another starter of the same type made by Westinghouse Electric & Manufacturing Co. The completed assembly can be bolted directly to the floor. In the center of the lower panel is the operator's lever for controlling the starting and running positions of the main line switches. Above, at the left, is the automatic field switch, in the center are two small-size meters and at the right is a small shunt relay used in the synchronous motor field during starting. Thermal overload protection is provided on the smaller ratings, oil dashpot overloads on the larger ratings.

Figure 3 shows still another starter of the same type built by General Electric Co. This starter consists of the following: a.c. ammeter, d.c. ammeter, field contactor with auxiliary contact for closing the discharge circuit during starting and stopping; field actuating relay; and a hand starting compensator which includes a temperature overload relay. A stop button is provided which when pressed, drops out the compensator switch and disconnects motor from line.

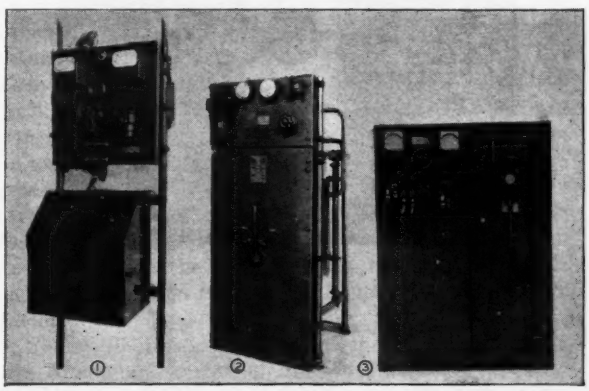


FIG. 1. SEMI-AUTOMATIC REDUCED VOLTAGE STARTER
FIG. 2. A SIMILAR UNIT BUILT BY THE WESTINGHOUSE ELEC. & MFG. CO.
FIG. 3. A GENERAL ELECTRIC CO. STARTER OF THE SAME TYPES AS SHOWN IN FIGS. 1 AND 2

Full-Automatic, Full-Voltage Starting

Minimum equipment for a starter of this kind will usually consist of the following:

(a) Main line contactor.
(b) Field contactor with discharge clip.
(c) A.c. ammeter.
(d) D.c. ammeters.
(e) Overload relays.
(f) Field control relays.
(g) Pilot light.
(h) Start and stop push buttons.
(i) Current transformers.
(j) Potential transformer (above 550 v.)

In this case the main line contactor may be either air break or oil immersed. As suggested previously in conection with semi-automatic starters the method by

which excitation is applied to the synchronous motor field is about the only essential difference between the different types of automatic starters as listed by various manufacturers. The overload protection used, varies somewhat; but otherwise the standard characteristics are much the same.

Sequence of Operation

As the full-automatic, full-voltage starter is probably the most popular type of starter in use today, it may be well to explain the control operation in some detail. The sequence of operation for these starters can best be explained by discussing illustrations of several different manufacturers.

Figure 4 shows two Ideal full-voltage, full automatic starting panels. These two starters are typical of small

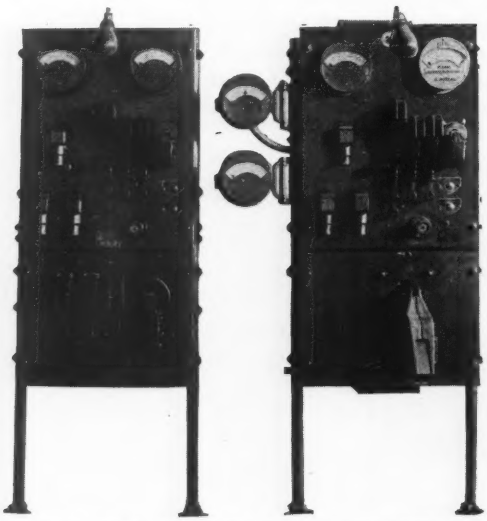


FIG. 4. TWO FULL VOLTAGE FULL AUTOMATIC PANELS

minimum starting panels for use with single motor installations. These minimum starters are not recommended for use in larger switchboard installations where it may be desirable to add panels from time to time matching original equipment. These two starters are essentially the same, except that the one on the left is a low-voltage panel using an air break main line contactor whereas the one on the right is a higher voltage (2200-v.) panel employing an oil switch mounted back of board with front of board closing mechanism. This latter panel also has two extra instruments, a voltmeter and a power-factor meter mounted on swinging brackets, and in addition a master control circuit relay mounted beside the switch the switch closing mechanism at the bottom of the panel. The control circuit relay is energized by a 2200/220-v. potential transformer and in turn acts as a master relay to energize the rest of the control circuit relays with 220 v.

The control circuit relays are usually a.c. operated from one phase of the incoming line. Above 550 v. it is necessary to employ a potential transformer for the control circuit so that low voltage only will be applied at the relays on the front of the panel. This is done as a safety measure for the operator's protection. Usually the potential transformer for the control circuit is used on the high-voltage side and grounded on the low-voltage side to fully protect the operator. In some particular localities, entirely dead front panels are required. This, however, is not standard practice, as the danger to the operator with standard panels is slight inasmuch as the control circuit voltage is always low.

Figure 5 shows another Ideal full-voltage, full-automatic starting panel, arranged as a unit to fit into a multipanel switchboard. A panel of this type presents a much more attractive appearance than minimum panels, for switchboard work. It also provides more panel space for auxiliary instruments. The 3-pole knife switch shown beside the main switch closing mechanism is used to start a motor-generator set for supplying direct-current excitation to the motor fields. This feature can be taken care of in various ways. Sometimes a separate hand-operated or push-button starter is provided for the motor-generator set. On other installations, the motor-generator set motor leads are connected directly across the main motor leads so that when the main switch goes in the motor-generator set is automatically started.

The sequence of operation for starters illustrated in Figs. 4 and 5 is practically the same. When the start button is pressed the main line switch operating mechanism is energized and closes the switch. The closing coil operating the switch closing mechanism seals the magnet and locks the switch in. In some cases, a mechanical latch is provided to lock the switch closed. This latch is then released by a trip coil when the motor is shut down for any reason. The two relays controlling the field circuit are also energized at the same time that the main switch closes. The accelerating or current limit relay holds in, until the inrush current has died down and then releases. The time relay functions a few seconds later, after allowing the motor to reach its maximum speed as an induction motor, to close the field contactor applying excitation to the motor, causing it to synchronize.

Figures 6 and 7 illustrate two more full-automatic, full-voltage starting panels (courtesy Westinghouse Electric & Manufacturing Co.). Figure 6 is a low-voltage starter and Fig. 7 is a high-voltage starter.

The sequence of operation for these starters is as follows: Pressing the start button energizes and closes the low-voltage relay, which in turn energizes and closes the main line switch, applying full voltage to the motor. The automatic field contactor is really contactors built into one, consisting of two poles up and one pole down with a common armature having two separately operated coils; the top coil being in the d.c. field excitation circuit and the lower coil in the motor field circuit. The lower coil holds the lower contactor closed, completing the motor field circuit through the starting discharge resistor, until the motor has reached approximately 95 per cent of synchronous speed. At this time the rapid decrease of the induced field current, which energizes the lower contactor, allows the top coil to open the lower contactor and to close the two top contacts applying d.c. excitation to the motor field, causing the motor to pull in step.

Figure 8 illustrates still another full-automatic, full-voltage starter (courtesy General Electric Co.).

The sequence of operation is the same again in this case except that the relays function in a different manner to obtain the same result. The operation of the

field actuating relay which controls the field contactor is dependent upon the speed of the motor and in addition a definite time relay after the motor reaches approximately 95 per cent speed. When full voltage is applied to the motor, the immediate closing of the field-actuating relay is prevented by a lockout coil in parallel with the field discharge resistor and energized by the voltage across the resistor. The lockout coil holds the relay contact arm motionless until the motor accelerates to approximately 95 per cent of synchronous speed, when

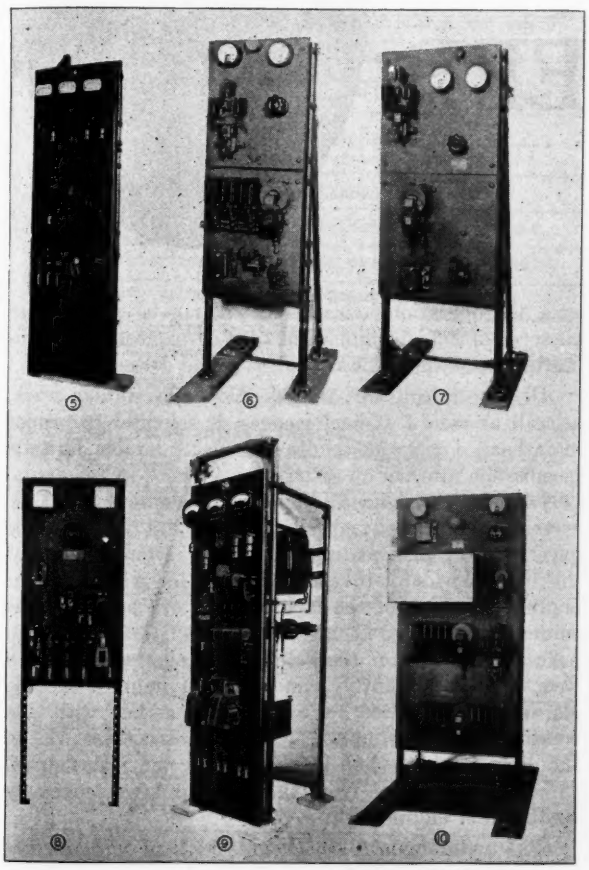


FIG. 5. FULL VOLTAGE FULL AUTOMATIC STARTER
FIG. 6. LOW VOTAGE AUTOMATIC STARTER (PHOTO, COURTESY WESTINGHOUSE)
FIG. 7. HIGH VOLTAGE AUTOMATIC STARTER (PHOTO, COURTESY WESTINGHOUSE)
FIG. 8. ANOTHER FULL AUTOMATIC FULL VOLTAGE STARTER (GENERAL ELECTRIC CO.)
FIG. 9. FULL AUTOMATIC REDUCED VOLTAGE STARTER
FIG. 10. SAME TYPE STARTER AS IN FIG. 9 (WESTINGHOUSE)

the voltage across the resistor decreases and allows the lockout coil to release the timing mechanism. After the predetermined time has elapsed, the relay contacts close, energizing the field contactor and applying excitation to the motor fields.

In all cases, when the stop button is pressed or the overloads trip, all control relays are deënergized, permitting line and field contactors to open. As the field contactor opens, the motor field is again short-circuited through the field discharge resistor.

Full-automatic, full-voltage starters are recommended for starting slow-speed synchronous motors driving compressors, pumps, and similar machines. Full-voltage starters are also used in some cases on higher speed synchronous motors for driving rubber mill lines, etc., when the higher inrush currents are permitted by power companies.

Full-Automatic, Reduced-Voltage Starting Panels

This last classification for starting controls employs practically the same equipment as the full-voltage starter except that an auto-transformer or other source of reduced voltage is required and in addition line contactors together with an extra relay for transferring from the starting to the running contactors.

Figure 9 shows a typical Ideal full-automatic, reduced-voltage starting panel. The auto-transformer, oil switches, and other auxiliary apparatus are mounted in a neat and compact manner back of the board.

Sequence of Operation

The sequence of operation in this case is the same as for the full-voltage, full-automatic starter except for transferring the motor from the starting to running contactors. That is provided for in connection with the above illustration, by a definite time relay. When the starting button is pressed, the control circuit relays are energized connecting the motor to predetermined taps on the auto-transformer and to the line. The motor accelerates until after a definite time delay has elapsed, the starting switch is released and the running switch closed. The completion of the starting sequence is then accomplished in the same manner as described previously in connection with the full-automatic, full-voltage starters.

Figure 10 illustrates another type of full-automatic reduced-voltage starter of the Westinghouse Electric & Manufacturing Co. The large dustproof cover on the front of the panel encloses a timing and transfer drum relay with its pilot motor.

The sequence of operation is as follows: Depressing the start button energizes the pilot motor of the drum relay. As the drum rotates, it energizes the various control circuit relays; closing the starting contactor which connects the motor to the reduced-voltage taps of the auto-transformer and the auto-transformer to the line. After a definite time interval, the start contactor is opened and the run contactor closed, the motor then accelerating under full-line voltage. A few seconds after full-line voltage is applied to the motor, the field contactor closes.

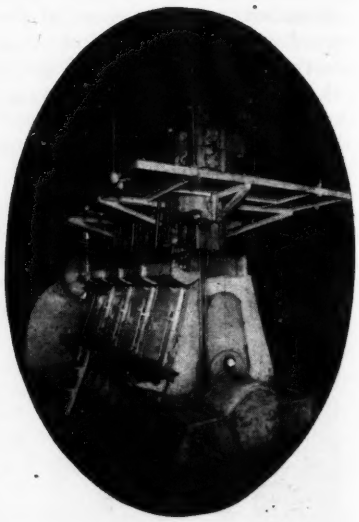
In connection with reduced-voltage starters of the automatic type, it is permissible to use air-break contactors for low voltage and for the smaller horsepower ratings. The switches are operated by quick-acting magnetic relays which minimize arcing at the switch contacts.

General Application

Full-automatic, reduced-voltage starters are recommended for starting medium and high-speed synchronous motors, driving pumps, generator sets, and all kinds of general purpose applications.

To secure the best results, all instruments should be under the care and supervision of one man.

DIESEL ENGINE UPKEEP



PART I. MAINTENANCE LOG WITH DEFINITE SCHEDULING OF INSPECTIONS AND EXACT INSTRUCTION FOR CLEANING, REPAIR AND REPLACEMENT INCREASES RELIABILITY AND DECREASES UPKEEP COSTS

PREVENTIVE METHODS rather than corrective methods are employed today in maintaining Diesel plants, hence we are experiencing increasing reliability accompanied by lowering costs in this form of power. Three factors predominate in reducing troubles in Diesel plants: Records and their analyses, application of devices that indicate promptly improper action and installation of equipment designed to remove harmful substances from such agencies of operation as air and oil.

Operation records are effective if they establish regular, timely and definite correction of minor defects before they assume such proportions as to have noticeable effect upon the operation of the machinery. They offer means for making repairs and replacements before actual breakdown or serious trouble arises. For this purpose, a monthly maintenance log such as illustrated is very effective. Listed on this log sheet are the various parts of the Diesel system that should receive regular inspection. They are given number designations as a means of reference better to provide for inspection and adjustment of coördinate parts of the engine as indicated in the fourth column. This reduces labor in making certain inspections by scheduling them when other parts which would otherwise be required to be disassembled have been taken apart for some other inspection, as when a cylinder head is cleaned out during piston inspection.

Elapsed time allowed between inspections is given in actual operating hours. This is preferable to stating this time in periods because, in some cases, a particular engine may have long intervals of inoperation such as in the case of standby service. The maximum elapsed times allowed, as given in column 3, are merely safe estimates. The maximum allowable periods will vary considerably with different types of engines and with different methods of operation. If a proper water softener is installed, there may be no need for cleaning out the cylinder jackets as no scale will form. Experience in the operation of any particular plant may show that a different time interval is satisfactory, in which case the time interval given should be changed. Likewise, the operation items listed will not be required by all types of Diesel engines but they cover nearly all regular inspection operations desired of all Diesel types.

Definite scheduling of inspection and similar work, as well as record of performance, is essential to proper maintenance, notwithstanding the considerable latitude permissible in order to satisfy convenience in the actual period of performance. Without a definite schedule, certain inspections and adjustments are likely to be overlooked or procrastinated. In the latter columns of the log, in which provision is made for a six-cylinder engine, the dates of the month which are posted in the columns designated A are supplied by the chief engineer on the bases of the actual running times for each item, collected monthly, and the maximum allowable elapsed time printed in column 3 together with due consideration of column 4. Column 3 is not essential to the shift engineer but is printed for his information. It could be omitted from the log and kept separately by the chief engineer.

The maintenance log should be kept prominently before the various shift engineers and the dates of performance of maintenance work properly posted by them as soon as maintenance work is accomplished. Division of this maintenance work may be made by the chief by designating the particular shift during which this work is to be done by posting a 1, 2 or 3 in one corner of the square. This method throws the responsibility of operation, as indeed it should, definitely upon one man, the chief engineer, who by this means, has a definite check upon his shift engineers.

Maintenance records of this kind are also exact bases for maintenance costs which can be posted each month on equipment inventory cards furnished for each individual piece of equipment. An equipment inventory system that may be conveniently employed in conjunction with the maintenance log described will be published in a later issue of this magazine.

Methods of maintaining the various parts of a Diesel engine, with definite instructions for cleaning, adjusting and repairing them, will be discussed in subsequent issues.

Engine No.....

MAINTENANCE LOG

Year.....Month.....

Actual running time for month, hours.....

A = Date work is scheduled
B = Date work was performed

No.	Operation	Max. elapsed time allowed hours	No. of oper. done same time	Cyl.1 A	Cyl.1 B	Cyl.2 A	Cyl.2 B	Cyl.3 A	Cyl.3 B	Cyl.4 A	Cyl.4 B	Cyl.5 A	Cyl.5 B	Cyl.6 A	Cyl.6 B
1	Engine pistons taken out and cleaned.	3600													
2	H.P. compressor pistons disassembled, cleaned and examined.	1800													
3	I.P. and L.P. compressor pistons removed, cleaned and examined.	1800													
4	Check clearance space between piston and head.	300	36												
5	Main cylinder jackets and heads cleaned out for scale.	3600	1-2 3-20												
6	Crankshaft and extended shaft alinement checked.	3600													
7	Crankcase flushed out.	1800													
8	Exhaust valves removed, cleaned and ground.	900													
9	Inlet valves removed, cleaned and ground.	1800													
10	Air intake valves removed, cleaned and ground.	1800													
11	Air starting check valves cleaned and ground.	1800													
12	Safety valves removed, cleaned and ground.	1800													
13	H.P. compressor valves removed, cleaned and ground.	600													
14	I.P. and L.P. compressor valves removed, cleaned and ground.	900													
15	Fuel valves removed, cleaned and needles ground.	900													
16	Fuel valve setting checked.	300													
17	Fuel pump valves examined, cleaned and ground.	1800													
18	Test spray checks for tightness every day.	10													
19	Camshaft gears or chains checked and adjusted.	600													
20	Cam roller setting should be checked every time a valve cage is changed or cylinder head removed.	3600	5												
21	Fuel pump driving mechanism should be examined.	600													
22	Valve gears cleaned, examined and corrected.	300													
23	Lubricating oil filter cleaned.	900													
24	Lubricating oil holes in crankpins cleaned.	1800	36												
25	Lubricating oil piping cleaned.	300													
26	Lubricating oil supply piping and tank cleaned.	3600													
27	Lubricating oil pumps cleaned and examined.	1800													
28	Examine lubricating oil piping for loose joints and leaks.	300													
29	Examine lubricator driving gears.	300	6-36 37												
30	Air injection piping burned out for carbon.	3600													
31	Air cooler coils cleaned out for scale.	3600													
32	Air receivers cleaned.	3600													
33	Air tanks drained and cleaned.	3600													
34	Check fastening of tube in bottle head.	900													
35	Wrist pin bearing checked and adjusted each time pistons are removed.	1800	1-2 3												
36	Crank pin bearing checked and adjusted.	1800													
37	Main bearings checked, adjusted for alinement and clearance adjusted.	3600													
38	Governor examined and adjusted.	1800													

Electricity---What It Is and How It Acts*

PART XXXVIII. THE NATURE OF THE RADIOACTIVE DISINTEGRATION PROCESS. SUCCESSIVE TRANSFORMATION FROM URANIUM TO LEAD. BY A. W. KRAMER

TO WHAT, MAY WE ask, are due the astonishing properties of radioactive materials? Why do these substances emit energy in a seemingly undiminishing amount? Where does it come from? In the preceding chapter, it was shown that the alpha ray consists of ionized helium atoms and the beta ray of electrons. Where does this helium come from? Certainly there is no helium mixed in with the radium or uranium or whatever the radioactive substance under consideration. Perplexing as these questions are we have been able, thanks to the infinite patience and persistence of Soddy and Rutherford, to construct a theory which accounts for all of these mysteries in a very satisfactory way.

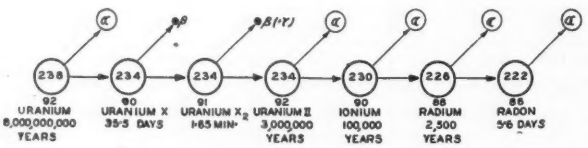


FIG. 1. SUCCESSIVE TRANSFORMATIONS OF RADIOACTIVE ELEMENTS FROM URANIUM TO RADON

The atomic weights are shown inside the circles while the atomic numbers are shown below.

As intimated in the previous chapter, the secrets of these mysteries are to be found in the instability of certain atoms. Atoms of ordinary elements such as iron or gold or oxygen are permanent, lasting for billions of years probably without change. Radioactive elements differ from ordinary elements in one respect and in one respect only. They are not permanently stable. The electrons and protons in such elements are so disposed and their energies are so distributed that for a certain length of time they get along well together but sooner or later trouble arises and they get into a jam, so to speak, and then something happens. The result is an atomic explosion in which a portion of these protons and electrons are ejected. These are the alpha and beta particles we have been discussing.

Now, in any given mass of radioactive substance, there are, of course, countless billions of atoms. Not all of these become unstable at the same time. At any given moment only a certain fraction of the total number of atoms in the mass become unstable and thus the disintegration process continues over a considerable period of time. This fact is responsible for the apparent continuous emission of energy from these substances. Ultimately, all the atoms in the mass will have gone through this process and the substance will not only be inactive but will be a different substance from that which it was before the disruption process. It must be understood that when an atom ejects an alpha particle or a beta particle in this manner, the residue of the atom thus disrupted constitutes an atom of an element entirely different from what it was before the disruption.

Thus, when an atom of radium loses an alpha particle it ceases to be radium. This, while it might seem strange at first, is rather to be expected. Let us refer back to the periodic table of the elements presented in Part XXXVI[1] and note the atomic number of radium. The atomic number of an element, it will be recalled, is really the thing that stamps an element what it is. The atomic number of radium is 88.

RADIOACTIVE PROCESS RESULTS IN TRANSFORMATION OF THE ATOMS

An alpha particle, it has been shown, is an atom of helium with atomic number 2. Now, what can we expect to find when an atom of radium loses an alpha particle? We find an atom with atomic number 86. This substance is neither radium nor helium; it is called radon or "radium emanation." In a similar manner, when an atom of radium emanation loses an alpha particle, it becomes an element with atomic number 84.

Such a new atom may or may not have the same atomic weight as other elements having atomic number 84, for we have seen that the atomic mass of an atom is due not to the resultant electric charge carried by the nucleus (which determines the atomic number) but by the total number of protons and electrons it contains. Atoms having the same atomic number but different atomic weights are said to be isoptic with each other.

Above we stated that at any moment a certain fraction of the total number of atoms in a mass of radioactive substance become unstable. Ultimately, therefore, all the individual atoms of a radioactive substance will undergo the same transformation. By some inner economy, however, they so arrange that at any instant a definite proportion of their number are engaged in the characteristic activities of the group, that is either hurling alpha particles or shooting forth beta particles. Thus, the life of any radioactive element is definitely limited. If only a small percentage of the total number of atoms become unstable at any instant, the element will have a long life while if a large percentage of the total engage in the characteristic activity of the group, the life will be short. Thus, the number of atoms in a sample of radium is always such a proportion of the whole that the average life of radium, regardless of whether the sample is large or small, is 2500 yr. Now, this does not mean that the world's store of radium will be exhausted in less than 2500 yr., for radium is constantly being formed from other radioactive elements just as radium is forming other radioactive elements lower down on the atomic scale. At any time, the amount of radium in existence in the world is a constant and is always a certain percentage of the amount of uranium in existence, for all radium is produced from uranium.

When we speak of the life of a radioactive substance, a natural question that arises is, how do we know what the life of a radioactive element is? How do we know

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[1]March 15 issue, p. 331.

that the average life of radium is 2500 years when it is only about 30 years since its discovery?

Determining the Average Life of a Radioactive Element

The answer to this question lies in the exact proportion in which the various radioactive elements are found to exist. It was found quite early in the investigations of radioactivity that the amount of radium present in a certain quantity of uranium was always a certain definite proportion of the whole. This also held true for other radioactive elements but the "factor of proportionality" in each case was different.

Since the radioactive process is one of disintegration, that is, of breaking down of heavier, complex atoms into lighter, simpler ones, it was natural to assume that these processes have their beginning in the heaviest of all elements, uranium. Uranium, with an atomic weight of 238 and an atomic number is the heaviest of all our atoms and with its positive nuclear charge of 92, also the most complex.

Uranium is the parent substance from which all radium is produced. Radium is found in all ores of uranium, and in no others. The amount of uranium in existence is always greatly in excess of the amount of radium, for uranium changes into lower radioactive products much more slowly than radium changes into products lower down on the radioactive scale. In other words, the life of uranium is very much longer than that of radium.

The average life of radium, we have said, is 2500 yr. Now, what is the life of uranium? This is determined as explained above from the constant of proportionality between radium and uranium. Rutherford and Boltwood together made exceedingly exact determinations of the proportion of radium to the amount of uranium existing in minerals. They found that for every one part of radium there always exists 3,200,000 parts of uranium. Knowing the life of radium to be 2500 yr., it follows that the life of uranium is $3{,}200{,}000 \times 2500 = 8{,}000{,}000{,}000$ yr.!

It is evident from this that the periods of average life of the radioactive elements vary greatly, but this is not the whole story. If the life of some is inconceivably long, that of others is inconceivably short. Radium C′, for example, has an average life of only one-millionth of a second.

When we speak of the average life of a radioactive substance, we mean that a certain definite proportion of the total number of atoms in a given mass disintegrate in a given time. Thus, when it is stated that the average life of radium is 2500 yr., what is meant is that if a mass of radium, say one gram, were set aside, at the end of one year 1/2500 of the radium will have disintegrated.

In referring to the time period of a radioactive element, it is more usual to make use of the time required for the element to be half transformed. For radium this period is about 1600 yr., which means that if one gram of radium were set aside, half of it would be unchanged 1600 yr. from now.

It is sometimes asked why radium of all the radioactive elements is so important, for there are others even more active. As expressed by M. A. Evans, "the principal reason is that radium has a period of half change long enough to be regarded as a practically permanent source of radioactivity but at the same time short enough to render it a highly active and concentrated source."

Growth of Radium from Uranium

When it was first thought that uranium was the parent substance from which radium is derived, attempts were made to substantiate the theory by actually determining the growth of radium from uranium. Frederick Soddy, first alone and later in conjunction with T. D. Mackenzie, conducted a series of experiments extending over many years to see whether uranium does, in fact, produce radium. The first results of their experiments failed to show this.

The natural explanation of this was that one or more intermediate elements of long life exists in the disintegration series between uranium and radium and such proved to be the case. Let us consider briefly the various steps in the transformation of uranium to radium. In Fig. 1, these are shown diagrammatically. At the left is represented an atom of uranium. Its atomic weight, 238, is placed inside the circle and the atomic number, 92, underneath. The average life of this atom is eight billion years; that is, at some time in a period of eight billion years such an atom is liable to become unstable and emit an alpha particle. Since an alpha particle has an atomic weight of 4 and a positive nuclear charge of 2, what is left after the ejection is an atom of atomic weight 234 and atomic number 90. This element is called uranium X_1.

Uranium X_1 has an average life of only 35.5; that is, an atom of uranium X_1 produced from an atom of uranium can look forward to an average existence of only a little over a month. This atom, when it becomes unstable does not emit an alpha particle but a beta particle. This, therefore, does not change the atomic weight but it does *increase* the atomic number, making it 91. This is obvious when it is remembered that the beta particle is an electron and carries a negative charge of one. Thus, since the negative charge of one is lost, the total positive charge on the nucleus is increased by one. This element with an atomic weight of 234 and an atomic number of 91 is known as uranium X_2 and this has a life of only 1.65 min. This again emits a beta particle (together with a gamma ray) and again the atomic weight remains unchanged. A new element is thus formed with atomic weight 234 and atomic number 92, which is known as uranium II, with a life of about 2,000,000 yr. Uranium II, it will be noted, is isotopic with uranium for it has the same atomic number but a different atomic weight.

Uranium II loses an alpha particle, making the atomic weight 230 and the atomic number 90. This is ionium with an average life of 100,000 yr. When this loses an alpha particle, which it does, radium is produced. This has an atomic weight of 226 and atomic number of 88. This we already know has a life of 2500 yr. When radium loses an alpha particule, it becomes an atom of radium emanation with atomic weight 222 and atomic number 86. This has a life of 5.6 days.

From this it is evident that due to the production of these intermediate products, the production of radium from uranium is extremely slow. For preparations containing the largest quantity of uranium, namely three

kilograms caculated as the element, the growth of radium after ten years was only five millionth of a milligram, i.e. one part of radium from fifteen billion of uranium. The problem of determining these facts has taxed to the utmost even the extraordinary delicate tests for radium.

From Radium to Lead

Having followed the disintegration process from uranium to radium or radium emanation, the next question is what happens to the emanation? Does this, too, break up into lower products and if so, where does this process end? It must end somewhere for certainly all elements are not radioactive.

The stopping point insofar as we can determine, is lead with atomic number 82. In passing from radium to lead, there is a loss of 5 helium atoms ($5 \times 4 = 20$)

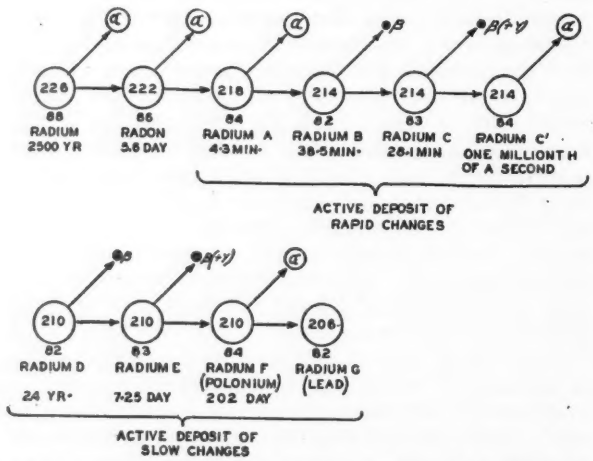


FIG. 2. FURTHER STEPS IN THE TRANSFORMATION OF URANIUM TO LEAD

In this diagram which can really be added to that shown in Fig. 1, the successive steps in the transformation of radium to lead are shown. There are two major series, one known as the rapid change series in which the life period varies from one millionth of a second to 38.5 min. and another called the slow change series in which the life period is from 7.25 days to 24 yr.

which means that the atomic weight of the lead produced by this transformation series should be 226 — 20 or 206. Ordinary lead from non-radioactive sources has an atomic weight of 207.22. Lead produced by uranium, therefore, is isotopic with ordinary lead.

In Fig. 2 are shown the various steps in which radium changes into lead. It is necessary to follow these steps in detail as the diagram is self-explanatory. It will be noted that there are two series of changes, one, through radium A, B, C and C′ which are rapid and another through radium D, E and F, which are slow. The average life of the atoms in the series of rapid changes is from one millionth of a second in the case of radium C′ to 38.5 min. for radium B. The slow changes vary from 7.25 days to 24 years.

The Displacement Law

As in the series of changes from uranium to radium, so also in the series from radium to lead, sometimes the atoms expel alpha particles and sometimes beta particles. The relation between the position of a radioactive element in the periodic table and the radiation expelled by the element may be expressd as follows:

1. The emission of an alpha particle by an element results in the production of an element having an atomic number *diminished* by 2, that is, it occupies a position in the periodic system two places lower down than does the parent element.

2. When the disintegrating element emits a beta particle, its atomic number is *increased* by 1, that is the product occupies a position one place higher than does the parent element.

This is known as the displacement law.

In this article, only the more important steps in the processes of radioactive disintegration have been presented in order to convey an idea of the nature of the processes. No attempt has been made to treat the subject exhaustively as that would require a volume and no better volume on this has been written than the one by Dr. Frederick Soddy,[2] to whom we owe so much of what we know about radioactivity.

It may seem that for a series of articles purporting to explain the nature of electricity, an unduly large amount of space is being devoted to this subject of radioactivity, which apparently bears only an incidental relationship to electrical matters. While this may be true in one sense, in another it is not for the whole radioactive process is electrical in nature and an understanding of the process has disclosed more about the ultimate nature of electricity than anything else. The radioactive rays have proved of inestimable value in investigating electrical processes and in succeeding chapters an attempt will be made to describe how the alpha particle has been used as a projectile of inconceivable power in certain fundamental electrical investigations.

[2]The Interpretation of Radium and the Structure of the Atom.

United States civil service Commission announces the following open competitive examinations:

Principal Hydroelectric Engineer, $5,600 to $6,400 a year; Senior Hydroelectric Engineer, $4,600 to $5,200 a year; Hydroelectric Engineer, $3,800 to $4,400 a year; Associate Hydroelectric Engineer, $3,200 to $3,700 a year; Assistant Hydroelectric Engineer, $2,600 to $3,100 a year.

Applications for the above-named positions must be on file with the Civil Service Commission at Washington, D. C., not later than May 7, 1930. The examinations are to fill vacancies occurring in the Engineer Department at Large, War Department, throughout the United States and in positions requiring similar qualifications. The entrance salaries are as indicated above. Higher-salaried positions are filled through promotion.

Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience and fitness.

Full information may be obtained from the United States Civil Service Commission, Washington, D. C., or from the secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city.

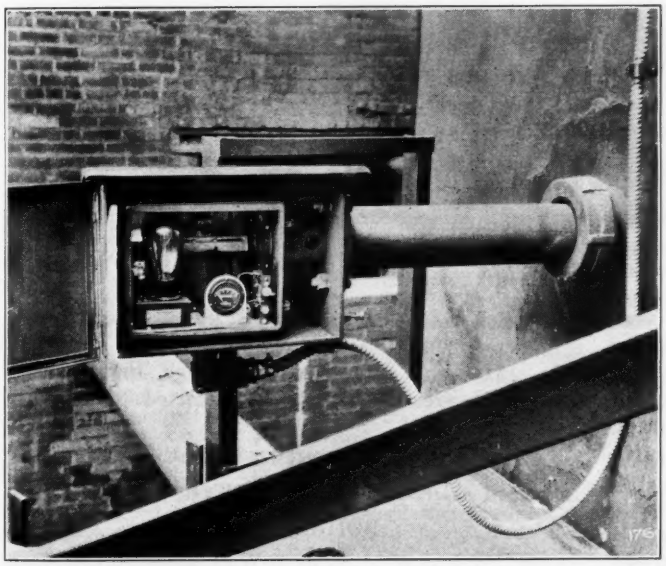
New orders for 881 steel boilers were placed in February, as reported to the Department of Commerce, by 81 manufacturers, comprising most of the leading firms in the industry, as compared with 942 boilers in January and 1042 in February, 1929.

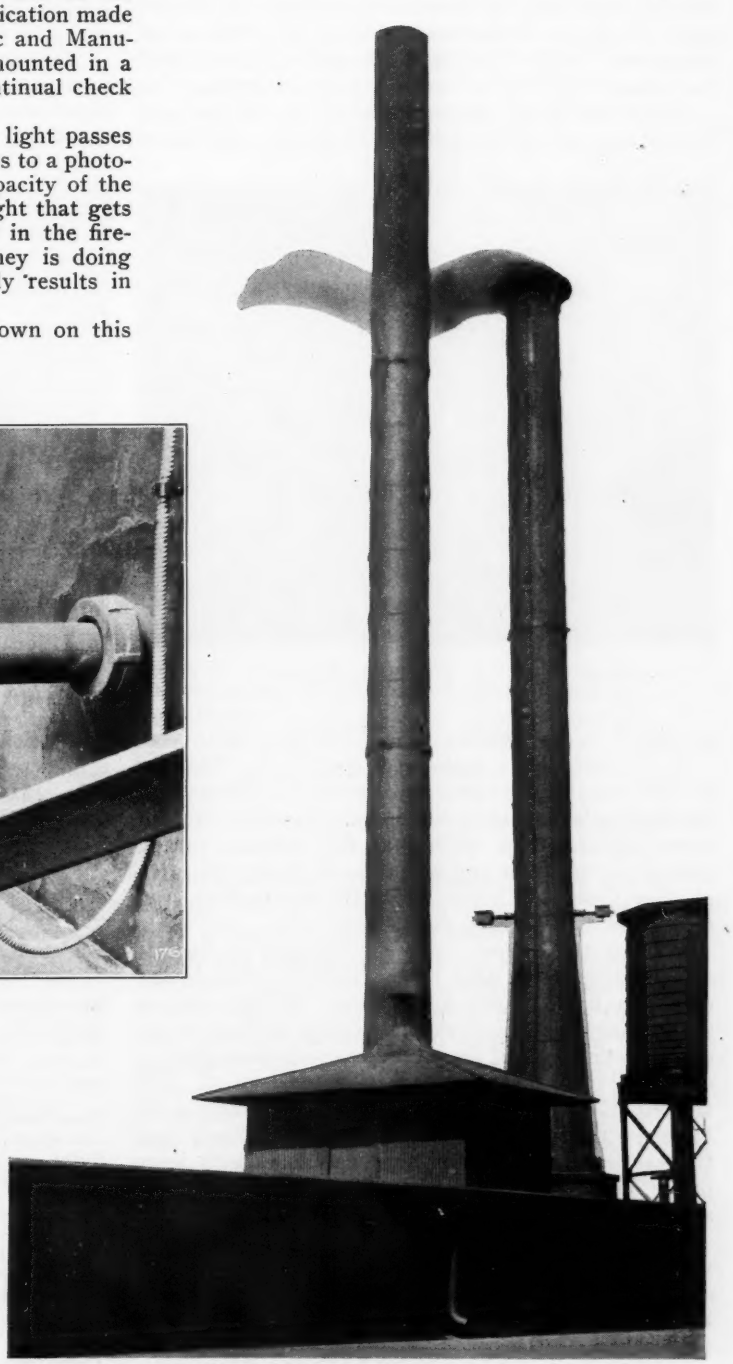
ELECTRIC EYE WATCHES SMOKE CONDITIONS

LONG MERELY an exhibition novelty, the photo-electric cell is now the brain of many commercial devices. A very practical use is in promoting efficient combustion in boiler plants. The appearance of the flue gases passing up the stack is a fair gage of the firemen's skill, and of the efficiency of the air supply. In an application made recently by the Westinghouse Electric and Manufacturing Co. a photo-electric cell is mounted in a smoke stack so that it maintains a continual check upon the amount of smoke produced.

From a lamp on one side, a ray of light passes right through the stack and its flue gases to a photo-electric cell on the other side. The opacity of the gases is measured by the amount of light that gets through, and is indicated on a meter in the fire-room. Knowledge of what the chimney is doing tends to intelligent firing, and actually results in a nearly clear stack.

An installation of this device is shown on this page.





Above is shown the mechanism of the photo-electric smoke detector. At the right is shown an installation of this device in the stack of a power plant. It can be seen about one-third of the way up on the right hand stack.

Georgia Power Co. Builds New Steam Plant

PLANT ATKINSON WITH AN ULTIMATE CAPACITY OF FOUR 60,000-KW. UNITS WILL BE IN SERVICE THIS FALL

RAPID PROGRESS is reported on the new Plant Atkinson now being built on the outskirts of Atlanta by the Georgia Power Co. Work was started May 10, 1929, and it is expected that the first 60,000-kw. unit, the largest in the south, will be in operation by September 1, 1930. The plant is located on the banks of the Callahoochie River, 9 mi. northeast of Atlanta.

When completed, the first unit will add 25 per cent to the capacity of the Georgia Power Co. and when completed to its ultimate capacity of four 60,000-kw. units will double the capacity of the system. The new plant is simple of design, consistent with efficient performance as a standby to the hydraulic system. Normal operating conditions will be at full capacity during periods of low water and probable emergency operation at other times as a protection to the metropolitan load center against lightning disturbance.

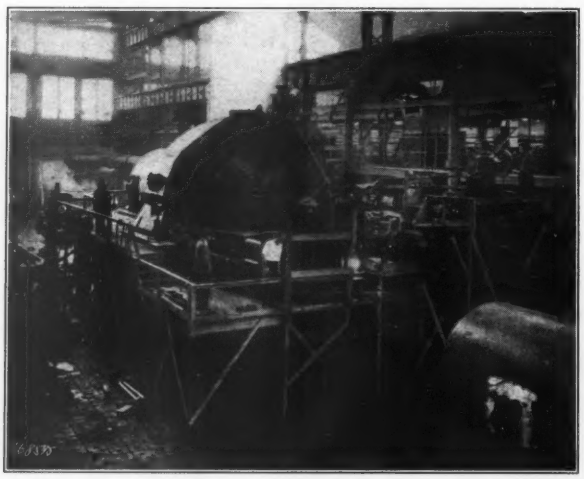


FIG. 1. SHOP VIEW OF THE FIRST 60,000-KW. TURBINE IN THE GENERAL ELECTRIC CO. SHOPS

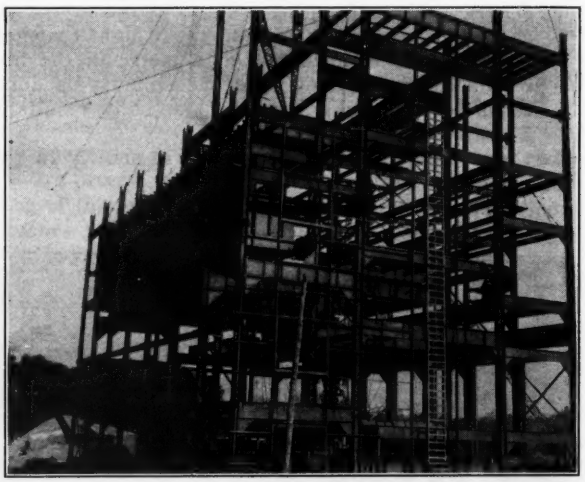


FIG. 2. STEEL WORK FOR PLANT ATKINSON WELL UNDER WAY

This is the largest single development in Georgia since completion in 1913 of the Tallulah Falls hydroelectric unit of 108,000 hp. capacity. It will serve as an auxiliary plant and will be capable of bearing the entire electric load of the Atlanta metropolitan district, even if all other sources of power should be cut off. The new plant's energy will be hooked up with the general hydroelectric system of the company in North and Central Georgia, which in turn, is linked with large power development projects in Alabama and other southeastern states.

Two 30,200-sq. ft. Walsh & Weidner, 400-lb. boilers with water wall and screens and 37,000 sq. ft. Ljungstrom air heaters will be installed to serve the 60,000-kw., 90 per cent power factor, 3-phase, 60-cycle, 13,800 v., 1800-r.p.m. General Electric turbo generator. A partial list of the other equipment is given in the tabulation.

By the end of January, the 100-a. tract had been cleaned, a 3-mi. roadway built to the state highway and 4200 ft. of standard gage, heavy standard rail forming a 40-car siding and a private spur to the Seaboard Air Line Railway had been completed.

Excavation for the plant and circulating water tunnels and coal handling equipment was almost completed and grading for the 100,000-t. coal storage well under way. Other work was in the following states of completion: concrete foundation, 90 per cent; structural steel, 60 per cent; conduit installation, 15 per cent; 15,000-gal. artesian water storage, 100 per cent, while boiler erection had just been started.

Principal Equipment for Plant Atkinson of the Georgia Power Co.

BOILER ROOM

Boilers, 30,200 sq. ft.	W. & W., Combustion Eng. Corp.
Superheaters	1 Foster Wheeler Co. 1 Superheater Co.
Water walls and screens	Combustion Eng. Corp.
Burners, 16-30" Lopulco "D"	Combustion Eng. Corp.
Soot blowers	Diamond Power Specialty Co., Combustion Eng. Corp.
Front wall	Bigelow-Liptak Co.
Ash sluice	Allen-Sherman-Hoff Co.
Boiler brickwork	O. H. Warwick Co.
Boiler refractories	Evens & Howard Co.
Feedwater regulators	Swartwout Co.
Coal Pulverizers, Raymond	Combustion Eng. Corp.
Fans: Force draft, 2 No. 13	Buffalo Forge Co.
Induced draft, 2 No. 15	Buffalo Forge Co.
Air preheaters, 2—37,000 sq. ft.	Air Preheater Corp.
Breeching and air ducts	Southern Iron & Equipment Co.

TURBINE ROOM

Turbo-generator, 60,000 kw., 90% P. F., 3 phase—60 cycles, 13,800 v., 1800 r.p.m.	General Electric Co.
Generator air cooler	General Electric Co.

Evaporator heater, 1200 sq. ft.....Foster Wheeler Corp.
High pressure heaters, 3.....Croll-Reynolds Eng. Co.
Low pressure heaters, 2.....Croll-Reynolds Eng. Co.
Tanks.....J. S. Schofields' Sons Co.
High pressure drainers.....Cochrane Corp.
Condenser and auxiliaries, 70,000 sq. ft., two pass.....
.....C. H. Wheeler Mfg. Co.
Oil filter.....S. F. Bowser & Co.
Automatic vacuum trip.....Consolidated Eng. Stop Co.

PUMPS

Boiler feed, 2-8 in., 6 stg.....Dean Hill Pump Co.
Make-up, 2, 1½ in.....Dean Hill Pump Co.
Sump.....Dean Hill Pump Co. and Goulds Pumps, Inc.
House service.....Ingersoll-Rand Co.
Ash sluicing.....Ingersoll-Rand Co.
Heater drain.....Ingersoll-Rand Co.
Deep well.....P. H. Cook Co.

ELECTRICAL

Motors, motor control and M. G. sets over 300 hp.....
.....Westinghouse Elec. & Mfg. Co.
Motors under 300 hp.....Allis-Chalmers Mfg. Co.
Carbon breakers.....Westinghouse Elec. & Mfg. Co.
Service switchboard.....Westinghouse Elec. & Mfg. Co.
Control bench board.....Westinghouse Elec. & Mfg. Co.
Indoor bus supports.....Electric Power Equip. Co.
Power transformers, 4-23, 333 kv-a.....
.....Westinghouse Elec. & Mfg. Co.
Oil circuit breakers.....General Electric Co.
Lightning arresters .....General Electric Co.
Disconnecting switches .....
.....Delta-Star Elec. Co. and Southern States Equip. Co.
Oil storage tank.....Birmingham Tank Co.
Transfer truck, 100 t.....Southern Iron & Equip. Co.

MISCELLANEOUS

Vacuum cleaning system.....Allen Air Appliance Co.
Crane, 125 t.....Shepard-Niles Crane & Hoist Corp.
Steel stacks.....Birmingham Tank Co.
Station piping.....M. W. Kellogg Co.
Valves:
600 lb. steel gate.....Chapman Valve Mfg. Co.
250 lb. steel gate.....Chapman Valve Mfg. Co.
125-150 lb. iron gate.....Chapman Valve Mfg. Co.
50 lb. iron gate.....Chapman Valve Mfg. Co.
125 lb. iron check.....Chapman Valve Mfg. Co.
600 lb. steel globe.....Edward Valve & Mfg. Co.
250 lb. steel globe.....Lunkenheimer Co.
Non-return 14".....Schutte & Koerting Co.
600 lb. blowoff.....Crane Co.
125" back pressure.....Crane Co.
Misc. small.....Wm. Powell Co.
Tanks, house service.....J. S. Schofields' Sons Co.
Venturi meters.....Builders Iron Fdy.
Water strainers.....Andale Eng. Co.
Expansion joints, rubber.....U. S. Rubber Co.
Expansion joints, copper.....Crane Co.
Traveling water screens.....Chain Belt Co.
Air compressor, 9½ by 6 in. Duplex.....Gardner-Denver Co.
Coal conveyors.....The Stearns Co.
Drag scraper, 200 t. per hr.....Sauerman Bros., Inc.
Coal crusher, 200 t. per hr.....Pennsylvania Crusher Co.
Coal weightometer.....Merrick Scale Co.

Simple Cost System for Small Plant

COST RECORDS, BY INDICATING TRENDS, CREATE INCENTIVE TO BETTER PREVIOUS PERFORMANCE, THEREFORE REDUCE COSTS. BY R. F. LEACH*

ALL LARGE POWER plants have power cost systems because any abnormal advance in any unit cost in such a plant will soon amount to considerable expenditure. Large plant cost systems are usually so elaborate that small plant managers usually refrain from adopting any adequate cost system.

*Chief engineer, power station, Boston and Maine R. R., Mechanicsville, N. Y.

Small plants, however, may account for costs in such a simple manner that no additional help is required to maintain them. In a method of this kind, established in our plant, we separate all costs in two divisions, operation and maintenance, and under each of these divisions we list the various principal items as illustrated, enabling us to segregate our expenses into unit costs.

For the collection of costs under the various items, I use a ledger page for each item, ruled to separate labor and material costs and I enter each expense as it is incurred or allocate the cost if it is distributed among two or more items. From these sheets I compile, on a monthly report page, the monthly costs incurred under

Month Dec. 1930

Operation

	Labor		Material		Total L&M		Comparison with Previous Month Decrease		Comparison with Previous Month Increase	
Wages Boiler Room	549	20			549	20				
" Engine Room	617	60			617	60				
Coal & Ashes	45	90			45	90				
Coal			3096	24	3096	24				
Water			60	63	60	63				
Lubrication			245	54	245	54				
Waste										
Supplies & Incd.			18	70	18	70				
Stores Exp.			16	39	16	39				
Total	1212	70	3437	50	4650	20				

Maintenance

	Labor		Material		Total L&M		Comparison with Previous Month Decrease		Comparison with Previous Month Increase	
Boilers	104	80	222	43	327	23				
Boiler Settings										
Stokers			276	43	276	43				
Engines	7	95	1	40	9	35				
Elect. Equip.										
Aux. Equip.			12	47	12	47				
Piping			5	38	5	38				
Buildings	39	39			39	39				
Coal & ash mchry.										
Total	152	14	518	11	670	25				

GRAND TOTAL - Operation and Materials $5320.45

SIMPLE MONTHLY POWER COST STATEMENT FOR SMALL PLANT

the various items. The thirteenth page of this set of monthly costs is reserved for the annual cost report which is compiled from these pages.

Keeping costs in this form not only presents power costs but a record of trends which act as an incentive to keep costs low. By this means, also, it is possible to single out the particular cost item or items that run abnormally high and exert major effort in reducing these particular costs to normal. This is also an aid in convincing the management of the desirability to purchase new equipment when such equipment is desired. We find, by recording the monthly decrease or increase in cost of the various items, that interest in bettering our previous record is aroused and it is certain that attention is directed toward avoiding wastes.

FEBRUARY SALES of mechanical stokers, as reported to the Department of Commerce by the 10 leading manufacturers in the industry, totaled 73 with 22,648 hp., as compared with 53 of 13,198 hp. in January and 80 of 31,554 hp. in February, 1929.

Paper Mills Find Economy in Central Power Plant

CROCKER, BURBANK & CO. OF FITCHBURG, MASS., REPLACE TWO OLD BOILER ROOMS WITH NEW PLANT CONSISTING OF THREE 500-HP., 400-LB. PRESSURE PULVERIZED COAL FIRED BOILERS AND THREE BACK PRESSURE TURBINES TOTALING 5500 KW.

POWER PLANT PROGRESS during the past few years is nowhere better typified than in the paper industry which as a whole has made strenuous efforts to take advantage of every economy to cut production costs.

Of recent paper mill plants, that of Crocker, Burbank & Co. at Fitchburg, Mass., is of unusual interest. This new plant which replaces two old boiler rooms, is designed for high rating, high efficiency operation and will supply steam and electric power for the two mills. Francis J. Sill, of Westboro, Mass., was consulting engineer.

Three Babcock & Wilcox, 500-hp., cross drum boilers, with Foster steam water and air cooled walls supply steam at 400-lb., 175 deg. F. superheat. Regular operation under these conditions shows an overall efficiency of better than 84 per cent. Each mill is fired by two burners supplied with pulverized fuel by an Aero motor driven 3-t. mill.

Coal burned is Pocahontas, running about 14,600 B.t.u. per lb. on a dry basis and pulverized to 80 per cent through 200 mesh after crushing. Power consumption for pulverizing runs about 17-kw-hr. per t. A

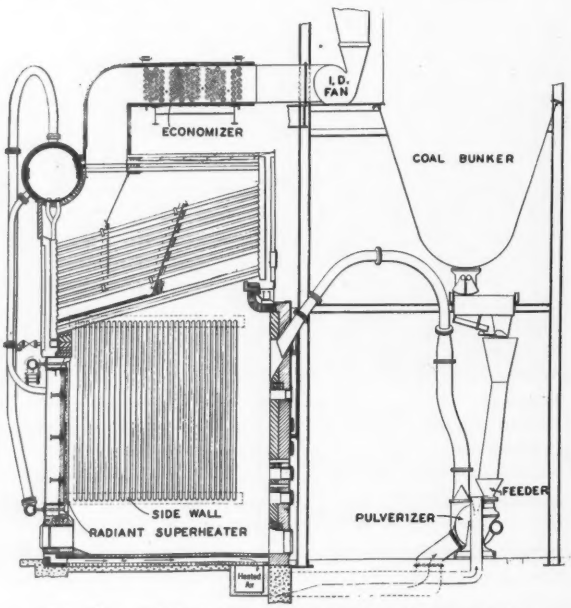


FIG. 1. CROSS SECTION OF THE BOILER ROOM

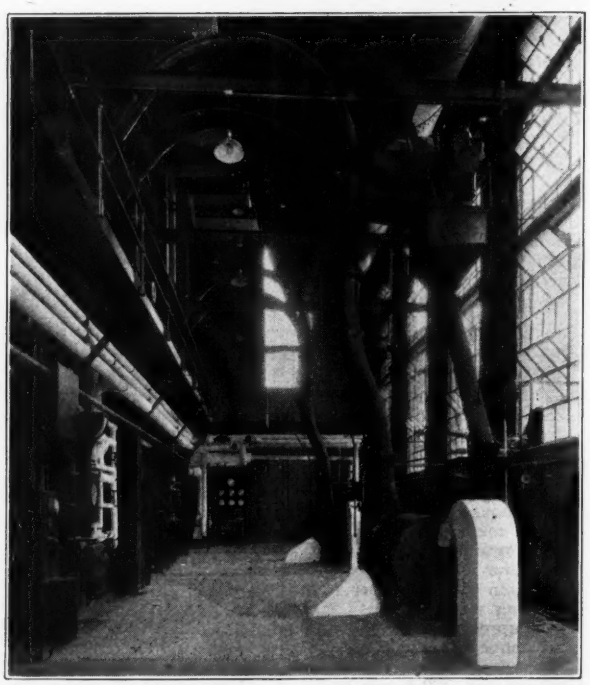


FIG. 2. FIRING AISLE OF THE CROCKER BURBANK CO. BOILER ROOM SHOWING THE EXCELLENT PROVISION FOR LIGHT AND VENTILATION

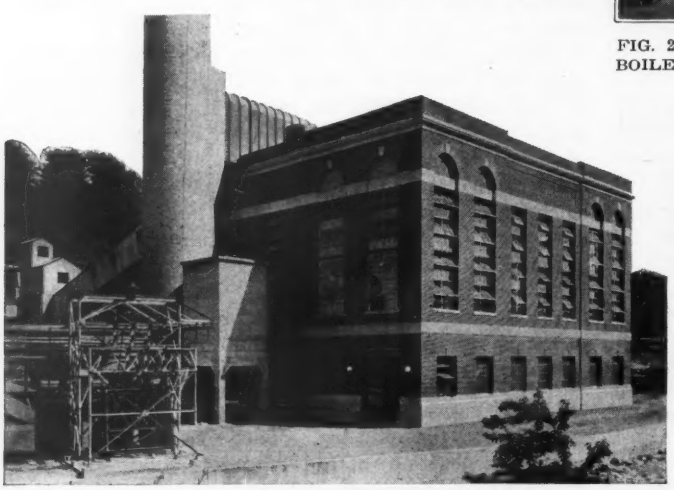


FIG. 3. AN EXTERIOR OF THE PLANT

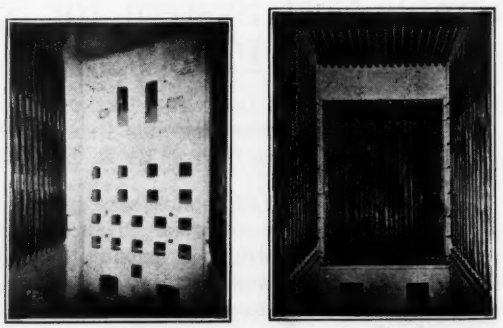


FIG. 4. FRONT WALL, STEAM COOLED BACK WALL AND WATER COOLED SIDE WALLS OF ONE OF THE FURNACES

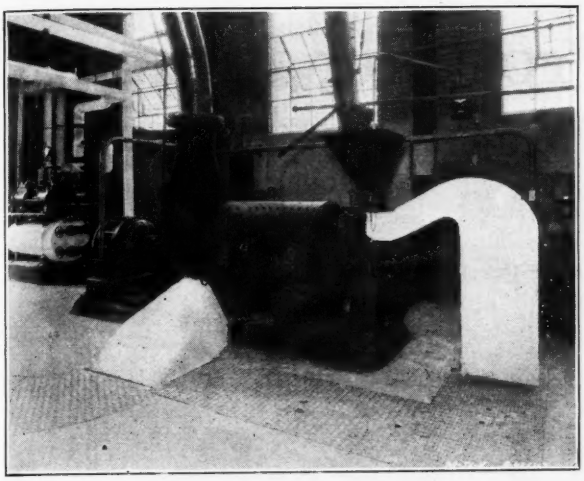


FIG. 5. ONE OF THE UNIT MILLS AND THE FUEL OIL SET (ON THE LEFT)

view of a portion of the boiler aisle is shown in Fig. 2 and a transverse section of the boiler room in Fig. 1. Figure 5 is a close-up of one of the mills showing the air duct arrangement and the fuel oil set and heaters used for starting fires and standby.

Each boiler has a heating surface of 4893 sq. ft. of boiler heating surface, 368 sq. ft. of water walls, 114 sq. ft. of radiant superheater and a 2511-sq. ft. economizer. Foster water walls, superheater and economizers supplied by Foster Wheeler Corp. are used on all units. The boilers are 17 rows wide and 15 rows high, the third and fourth rows being omitted. The furnace volume is 3450 cu. ft., a ratio of about 0.655 cu. ft. per sq. ft. of boiler water heating surface. Normal boiler output is 44,000, and maximum 60,000 lb., of steam per hour. The maximum heat release is about 25,000 B.t.u. per cu. ft. of furnace volume.

Furnace and wall construction is unusual and is designed to give flexibility over a wide range of load conditions. Water cooled side walls are made of bare tubes closely spaced and backed by refractories. The front wall is of refractory; the floor is air cooled Carborundum tile, the heated air going direct to the mill, and the back wall is cooled by radiant heat superheaters. Primary air reaches the mill at about 250 deg. F. This type superheater takes little space and cuts down the headroom required by the boiler. Furthermore the superheat droops at higher ratings, a desirable characteristic in this case where the turbines discharge against a fairly high back pressure. Economizers are placed on their sides as shown in Fig. 1, giving an exceedingly compact arrangement. Forced draft fans, driven by slip ring motors, have a capacity of 30,000 c.f.m. each against a static pressure of 6.25 in. of water. One 200-ft. stack serves the three boilers.

Feedwater is taken either from the river or city supply and heated to about 215 deg. F. in an open deaerating heater supplied with exhaust steam.

Electric power is supplied by a flexible arrangement of three Westinghouse impulse-reaction turbines operating against a back pressure of 50 lb. abs. These units are rated at 3000, 1500 and 1000 kw. respectively, 3600 r.p.m., 2300 v., three-phase, 60-cycle, 80 per cent power factor. Each generator is supplied with a closed air cooling system and air washer. Excitation is supplied by three cross connected motor generator sets, two 30 and one 20 kw.

House power supply is taken from a bus on which one generator is paralleled with an outside transmission line. The plant is tied in with the public utility 13,500-v. lines through three 1000-kv-a. single phase transformers connected delta-delta and shown in the left-hand corner of the headpiece.

Illinois Utilities Meet in Springfield

ANNUAL JOINT SESSIONS of the Illinois Utilities Associations were held Mar. 19 and 20 in Springfield, Ill., with nearly 1000 representatives from all parts of the state attending. At the annual elections, vice-presidents were elevated to head the various groups. Oliver R. Hogue, Commonwealth Edison Co., Chicago, became president of the Illinois State Electric Association, succeeding E. F. Kelly, Springfield; Guy A. Richardson, Chicago Surface Lines, president of the Illinois Electric Railway Association, succeeding C. H. Jones, Michigan City, Ind.; and Howard T. East, Chicago, Public Service Co. of Northern Illinois, succeeding E. E. Lungred, Aurora. George W. Schwaner, Springfield, was re-elected secretary-treasurer of the three groups.

A. D. Mackie, vice-president and general manager of the Illinois Power Co., was elected vice-president of the electric association; R. B. McDonald, Moline, and H. A. Johnson, Chicago, were named first and second vice-presidents of the railways organization; and H. A. Kleinman, Moline, vice-president of the gas utilities group.

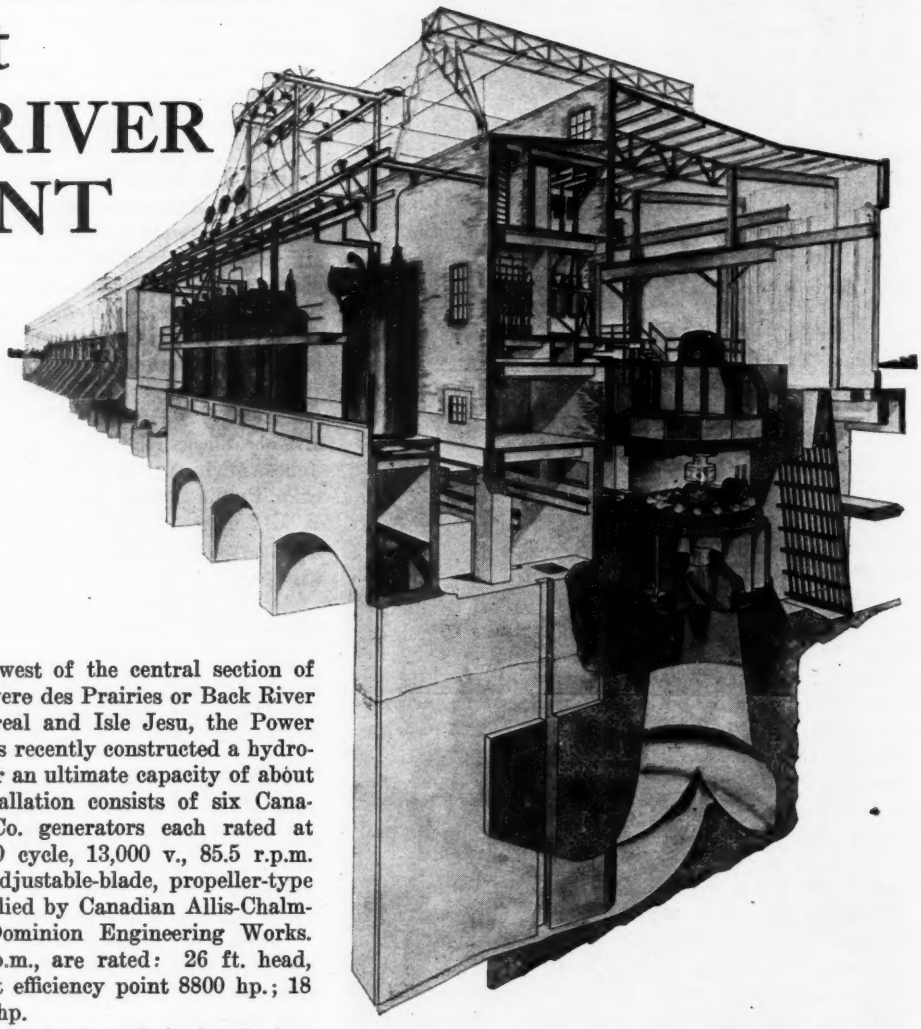
Tyler G. Price, an employe of the Commonwealth Edison Co., won the state-wide utility public speaking contest; Hjalmer Oyen, Rockford Electric Co., was second; and Carroll E. Eichhorn, Public Service Co. of Northern Illinois, third. A rural electrification exhibit was a feature of the gathering.

Farm electrification in Illinois has progressed beyond the experimental stage, J. Paul Clayton, Springfield, vice-president of the Central Illinois Public Service Co., told the gathering. Up to the present, however, the service has not paid its way, except where large amounts of power have been used. Lee J. Quasey, director of transportation of the Illinois Agricultural Association, estimated that complete electrification of 225,000 farms in the state would require expenditure of $310,000,000 and he suggested that a program of adding 4000 farms annually to the system be attempted.

Bernard J. Mullaney, president of the American Gas Association, addressing the opening session, charged that the federal trade commission is attempting to deny the public service companies the right to advertise their business by interpreting all efforts to cultivate good will—even rate reductions—as propaganda against government ownership.

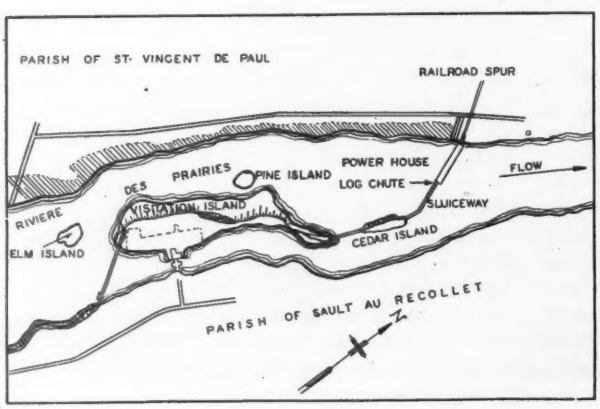
Governor Louis Emmerson, addressing the opening session, touched upon the central theme of the gathering in an emphatic manner. "I want to urge upon you utility experts, who represent the important chance in the industry," he said, "and upon you agricultural leaders, who represent the farms, the need of a closer association and greater co-operation among all classes in the interest of the common good."

Adjustable Blade Propeller Runners at BACK RIVER PLANT



EIGHT MILES northwest of the central section of Montreal, on the Rivere des Prairies or Back River between Island of Montreal and Isle Jesu, the Power Corp. of Canada, Ltd., has recently constructed a hydro-electric plant designed for an ultimate capacity of about 120,000 hp. Initial installation consists of six Canadian General Electric Co. generators each rated at 10,000 kv-a., 3 phase, 60 cycle, 13,000 v., 85.5 r.p.m. and each driven by an adjustable-blade, propeller-type water turbine, three supplied by Canadian Allis-Chalmers Co. and three by Dominion Engineering Works. These wheels, at 85.7 r.p.m., are rated: 26 ft. head, maximum 12,000 hp., best efficiency point 8800 hp.; 18 ft. head, maximum 7150 hp.

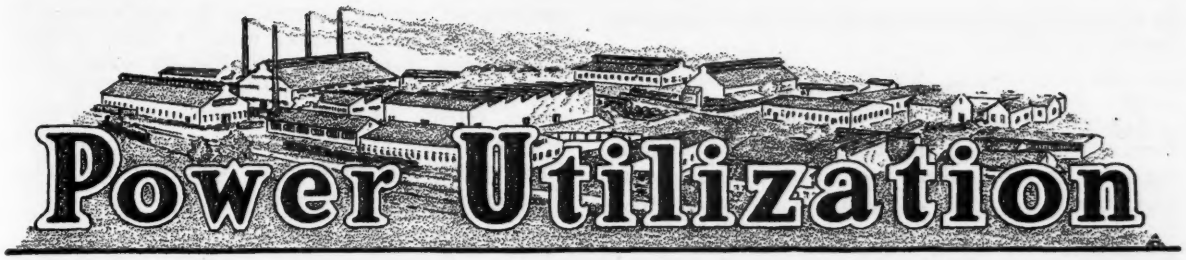
Adjustment of turbine blades is made by hand when the unit is stopped, requiring about five minutes' shutdown but not necessitating unwatering of the unit. Mechanism for adjusting the blades is mounted between the coupling flanges of turbine and generator shafts. The illustration at the left shows a model of the adjusting mechanism of the Dominion turbines. Woodward governors are used on the three Dominion turbines and Allis-Chalmers governors on the others.



Three 15,000-kv-a. Canadian General Electric, single-phase, 13,000/66,000-v. transformers serve the present units, the switchboard and switchgear being furnished by the same company.

Two of the six units now installed are equipped with underwater ejector passages with two openings per unit discharging directly from the intake into the draft tube. Each opening is controlled by a gate 8 ft. 3 in. high and 12 ft. 6 in. wide; the pair of gates under one unit is capable of passing 5700 c.f.s. at 18 ft. head. Tests on a model of the complete installation, by the power company engineers, showed that a gain of about 1000 hp. may be expected by the use of the ejector gates. Two additional units are to be similarly equipped.

General construction of the plant has been carried out by Messrs. P. Lyall & Sons Construction Co., Ltd. Design and supervision of construction have been by the Power Corp. of Canada, Ltd., of which J. F. Roberts is hydraulic engineer.



Industrial Substations—I

ARRANGEMENT, TYPES, CONSTRUCTION, SAFETY PRECAUTIONS. BY OTTOMAR H. HENSCHEL*

EVER INCREASING use of purchased electric energy by the industries, accompanied by the lowering of rates under various conditions of ways of taking this energy from the distribution lines of the utilities, has brought the advent of the industrial plant substation. Some of these substations are of exceedingly simple construction, in instances consisting of but a single transformer of suitable capacity being hung upon a pole outside of the plant. Others, particularly the larger units, are elaborate structures housing either in or out of doors, one or more large sized transformers together with the necessary switching, protective and control equipment and apparatus.

CUSTOMER BUYS AT TRANSFORMER PRIMARY

Economics, rather than engineering, appears to have brought about this change in the method of serving the industrial plant. Up to the present time, it has been customary, in the majority of cases, to have the utility companies provide all of this equipment. But, with energy purchased on a secondary metering arrangement, transformer losses, naturally, have to be charged to the consumer. Account is also taken, of demand and system power factor, control of which is, obviously, always beyond the utility. With this scheme, then, rates are bound to be comparatively high; not unjustly so, but sufficient to protect the central station company against the detrimental effect of excessive demands and needlessly low power factors.

On the other hand, by checking delivery of energy on the secondary side of the transformers, all losses taking place within them can be readily accounted for, penalties levied and bonuses provided for variation in demand and power factor. That is, having the consumer purchase and install all of his substation equipment within a suitable housing, or in the case of the outside type of station, upon a suitable plat of ground within his premises, has proved advantageous to both consumer and utility. The former, by proper adjustment of demand and power factor can readily enjoy the benefits of a minimum rate while the utility is relieved from the necessity of investing large sums of money which would otherwise be necessary.

In fact, this arrangement has in some localities proved a source of revenue to the central station companies in that, when such a substation is proposed to be built the utility will offer to do this, supposedly at cost. Frequently, however, industries find it possible, by the utilization of their own forces, and under competent engineering supervision to construct the same unit at a cost considerably lower than that asked by a local utility or electrical contractor. It is, of course, understood that, in such cases, the industrial plant purchases

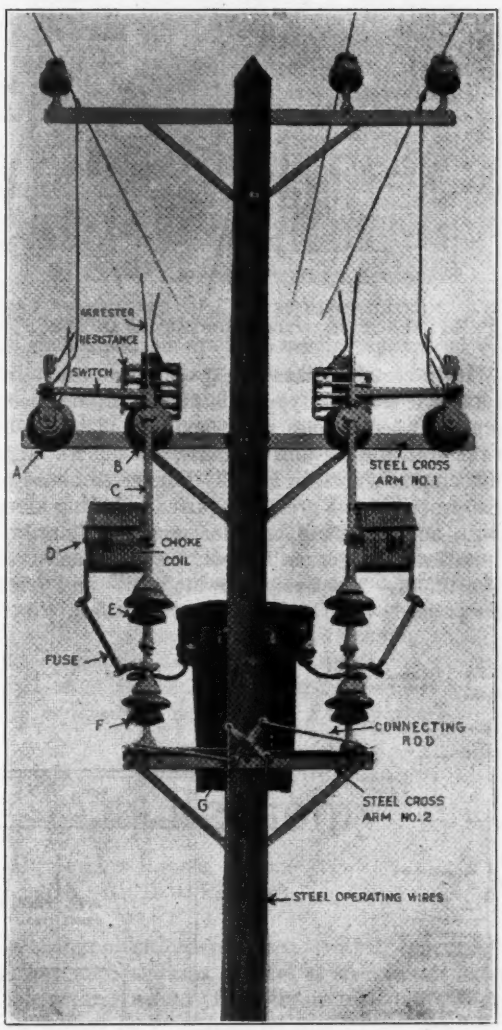


FIG. 1. SMALL POLE-TYPE OF SUBSTATION

*Consulting engineer, Milwaukee, Wis.

its equipment and apparatus directly from the manufacturer or jobber.

Types of Substations

Generally speaking, there are two types of transformer substations, (a) the outside (a type rapidly gaining favor over the other) and (b), the inside station. The essential difference between these two is obvious, as the names imply and will, therefore, call for no further explanation.

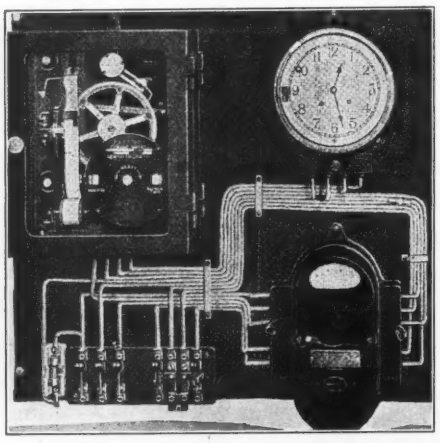


FIG. 2. METERING HOUSING AND EQUIPMENT USED IN CONJUNCTION WITH SUBSTATION IN FIG. 1.

Within certain limits of capacity, as perhaps up to 200 kw., the simplest type of outdoor substation consists of a pole, or set of poles, connected by a platform, carrying the transformer unit or units, the general arrangement being as shown in Fig. 1. Connected ahead of the transformer or bank are the required lightning arresters, cutouts and metering transformers. Ordinarily, secondary leads are carried from the last named to the kilowatt-hour, reactive kilowatt-hour and demand meters, which may be placed either within a suitable weatherproof housing mounted on the pole within a few feet of the ground, or housed within a nearby building. With service distribution protected by switches and fuses at the main entrance within the building being served, cutouts on the secondary side of the transformers are not, as a rule, required. Pictured in Fig. 2 is a typical meter housing and equipment such as used in conjunction with a substation of this type.

Special Structures

With stations of greater capacity than about 200 kv-a., and particularly for high-voltage conditions, such as 13,200 or 26,400 v. and above, more elaborate and extensive structures and equipment are required.

Considering a station supposed to have a rated capacity of from 350 to 400 kv-a., with the present-day types of transformers, this may be built up of either a single 450-kv-a., three-phase unit or two 200-kv-a., single-phase units as in Fig. 3, connected in open delta, an arrangement providing a capacity of 0.86 times 400 kv-a., or 344 kv-a. Which one of these schemes should be employed may prove somewhat problematical.

Current practice, however, appears to favor the latter arrangement, because with it the ultimate capacity of the station may be readily increased to 600 kv-a., the installation of an additional 200-kv-a. unit and the employment of a closed delta, without further changes or additions to other parts of the station; also that, with the three single-phase units so connected, injury to any one of them need not necessitate complete suspension of service. Obviously, too, in the case of repairs or replacement, one single-phase unit will require less expense than would be involved in the case of a three-phase transformer.

Typical Examples

Figure 4 illustrates diagrammatically a typical station employing two 200-kv-a., single-phase transformers connected in open delta and with space within the station proper provided for a third unit whereby, as explained above, the station can be made to have an

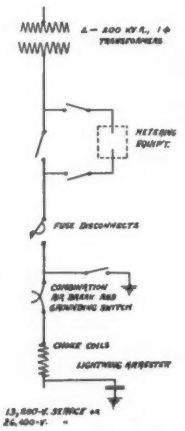


FIG. 3. SCHEMATIC DIAGRAM OF CONNECTIONS OF AN OUTDOOR SUBSTATION FOR TWO 200-KV-A., SINGLE-PHASE TRANSFORMERS AND ARRANGED FOR LIKE ADDITIONAL UNIT

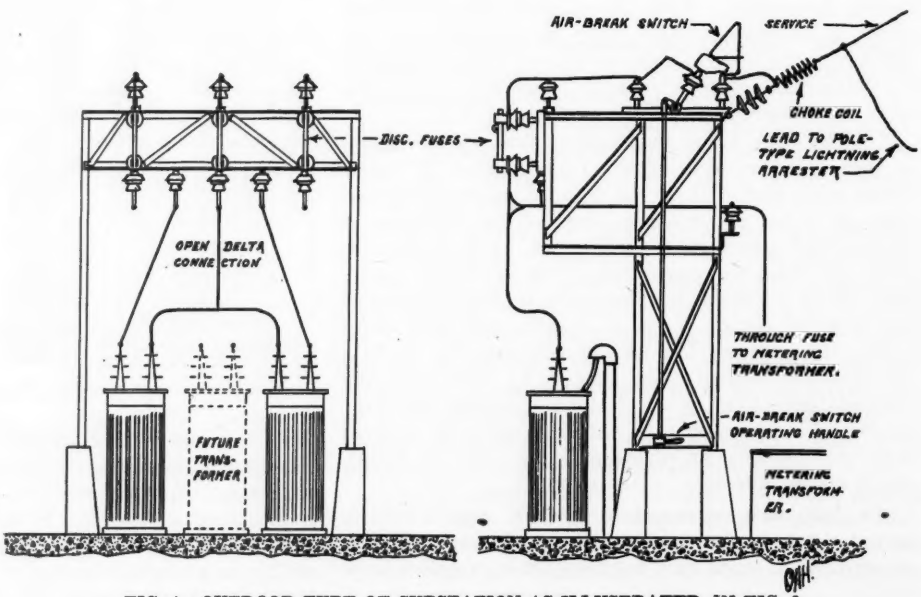


FIG. 4. OUTDOOR TYPE OF SUBSTATION AS ILLUSTRATED IN FIG. 3

ultimate capacity of 600 kv-a. In this particular instance, energy is supplied at 26,400 v. three-phase with the voltage stepped down to 240 v. for distribution throughout the plant, a mid-western malleable iron foundry.

While, in installations of this type, lightning arresters of the pellet oxide film or electrolytic types may be used, in the case under discussion the first named was employed. These are mounted on a pole immediately outside of the station in order to conserve all floor space possible. Directly following this are three 100-amp., 37-kv. strain type choke coils with bird guards, anchored to the structural steel work through the medium of strain insulators. A lead from the strain insulator side of the choke coils connects with the 37-kv., 300-amp., three-pole, single-throw, vertical air-break switch. This switch should always, as in this case, be fitted with sleet guards and should be arranged for manual gang operation through the medium of a suitable mechanism terminating in an operating lever located at the side of the structure and within easy reach of the ground. Built integral with the airbreak switch should be a grounding switch, so as to allow immediate grounding of the station electrical equipment on the consumer's side in the event the main switch may at any time be opened.

Suitable insulators carry leads made up of No. 0 hard-drawn wire to the disconnect fuses shown and which should at all times be readily accessible from a suitable and properly located platform. In this particular installation, no such platform is shown as this has been built into the walls of a building adjoining the substation.

Passing through the necessary metering current and potential transformers, the energy is delivered to the two 200-kv-a. transformers, from which, at 240 v., it is carried to a main distribution panel located within the foundry building proper.

Suitable switches should be provided to allow disconnection of the metering transformer and bypassing of the energy during such periods.

Hot galvanized iron angles are preferably used in the construction of the structure. While in some instances this is built up directly from the ground level concrete footings, higher footings, also of concrete, may be utilized with a reduction in size and quantity of structural steel.

Approximately, but 2600 lb. of structural steel are required for a unit of this type and capacity. Wherever members are joined, rustproof bolts are advised to prevent untimely rust and corrosion.

In the construction of a station of this type, particular attention must be given to the mounting height of the lines serving it. Requisite clearances of such lines from rails, streets and highways are, according to accepted codes, as follows:

LINES WIRE CLEARANCES OPERATING VOLTAGES

Crossing is above	300 v. to ground, up to 15,000 v. between conductors	15,000 v. to 50,000 between conductors
Rail road tracks	28 ft.	30 ft.
Streets or alleys in cities	20 "	22 "
Streets or roads rural districts	24 "	24 "
Roads or other places for vehicles	18 "	20 "
Spaces for pedestrians only	15 "	17 "

PROTECTION

Because of the comparatively high voltages ordinarily maintained on the lines serving industrial plant substations, precautionary measures should be taken to insure safety of life and property. Accordingly, all equipment should be properly fenced in. For stations such as under discussion, it is recommended that heavily zinc coated, or hot galvanized, chain link wire fencing made up of No. 9 gage wire woven into a 2-in. diamond mesh and erected to a height of at least 17 ft., in compliance with the above table, be installed around the equipment. In addition should be a reinforcement of, perhaps, No. 18 gage, ¼-in. mesh netting carried to a height of approximately 8 ft. This fencing should be fitted with gates of such size as will allow the entrance and exit of authorized persons and the possible movement of equipment into and out of the station.

Variable Speed Drives Aid Economy

LESS POWER FOR LOW LOAD. GREATER OUTPUT ON LIGHT WORK. SPEED FITTED TO VARYING FACTORY CONDITIONS. BY E. J. PATTON*

FIFTEEN OR TWENTY years ago, I owned what was advertised as a "single speed" motorcycle and the man who named it had evidently ridden one. To start it, I would give a mighty push and when it fired, get on, if I could. To a certain extent, I could control its speed and by jamming the brake could even turn corners but life was certainly exciting. Later, the so-called "three-speed" model came out and my existence became almost humdrum. The machine could be slowed to a walk or urged to a roar by an easy twist of the wrist. It was a real example of the advantage of speed control.

Modern applications of speed control, especially in large shops and factories, are not as spectacular but are of much greater value. Industry is realizing the practical advantage to be gained by controlling the operating speed.

Almost every mechanical or chemical operation is influenced by varying conditions, ranging all the way from atmospheric moisture and temperature to the morale of the operators. These variables and many others make life most interesting for the factory executive responsible for producing a uniform product at a reasonable cost.

In the power plant the worry is how much and when

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the factory uses power, as there is choice of arranging for machinery either variable speed drives which can be regulated to turn up the highest practicable speeds for the conditions involved or constant speed drives that have to be timed for normal conditions.

At best, the latter method is a compromise. If conditions are good and the sailing is smooth, there should be greater production from machines and men. On the other hand, if difficulties pile up, it is a case of hustle to keep up or run the chance of a slighted product and the waste of accompanying rejections.

For constant speed drives, the power problem is simplified and with a given number of machines at work the load will be fairly constant. On the other hand, using variable speed drives of high efficiency there will likely be varying load to meet. When machines are slowed down, load drops and again, when eased into high speed, the power supply must must meet an increased demand. Ordinarily this rise and fall in load can be anticipated and will result in a real power saving.

In other words, by driving machines through well-designed variable speed transmissions, power demand

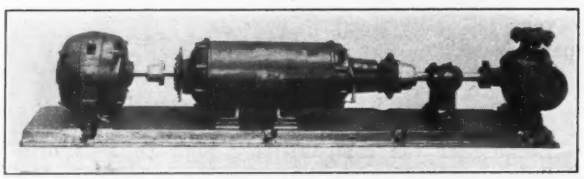

FIG. 1. 1200-R.P.M. MOTOR DRIVING PUMP AT 24 TO 144 R.P.M.

rises and falls almost in proportion to the speed of the driven machines, with a considerable saving at light loads.

It is unfair to rest the case for the variable speed drive with the saving in power. The actual gain through increased production and a more uniform product from the same machinery is probably of even greater importance.

With a variable speed drive, a machine can be operated at any speed within a reasonable range. The lower speeds are slow enough to enable the process or operation to be completed under the worst conditions. As conditions improve or new operations requiring less time are attempted, the machine can be speeded up with a consequent increase in production. Not only can the speed be increased but, with most variable speed drives, it can be brought to and held at exactly the proper speed for hours at a time.

Speed Control Methods

Two methods are used of controlling operating speeds, by means of variable speed motors and by the use of mechanical speed changers, which are now developed to a high degree of efficiency. The direct-current motor is quite flexible but the scarcity of direct-current supply limits its application. The variable-speed alternating-current motor in the larger sizes is rather bulky with its several sets of windings, high in first cost and somewhat limited in range of speeds. In many cases the efficiency is not all that might be desired.

Most types of mechanical speed changers have range of as high as 5 to 1 and are designed for use with the efficient, high-speed squirrel-cage motor, which is both compact and reasonable in cost. As an example of the flexibility to be expected, one style of variable-speed transmission, when driven by a 1200-r.p.m. electric motor, will deliver the power to a pump at reduced speeds which can be varied from 24 to 144 r.p.m., as seen in Fig. 1.

Practically all types on the market are self-contained, some are quiet, and nearly all are as easy to mount as an electric motor. Some styles are entirely enclosed and can be mounted in any position without danger of injury from dust or dirt. Usually, output speeds can be regulated while the machine is in motion, a feature which eliminates interruption in operation.

Remote Control

One of the most recent developments is the application of electrical remote control, whereby the superintendent can change the speeds without leaving his desk. The usual control wheel or crank is replaced by a spur gear, driven backward or forward by means of a compact control motor. The control box can be located at any distance from the drive and the operating speed is increased or decreased simply by pressing on one of two buttons. As long as the increase button is pressed, the variable-speed transmission continues to increase its output speed. When the desired speed is reached, the button is released and the drive speed remains constant until a new speed is needed.

Variable-speed drive works well into the scheme of the 24-hr. day. Instead of one or two 8-hr. shifts, many important processes are operated continuously, 24 hr. a day. This plan has two advantages. Expensive machines are now actually worn out through use, rather than junked for obsolescence, as of old; and operation is continuous. Unquestionably, in starting a day it takes both men and machines a certain period to warm up, both figuratively and literally. Then, at the end of the one-shift day, comes another costly period when one job is being finished and it is too late to start another. In both the one-shift and the continuous days the human element has the same high and ebb tides of efficiency. Here the variable-speed drive enters to enable the machines to keep pace with the operators.

Before and after figures, giving comparative power costs and production data, on old installations where fixed speed has been replaced by variable speed drives are almost impossible to get. They are guarded jealously but we can draw a reasonably accurate conclusion from the records of one transmission manufacturer. These show that 77 per cent of the new transmissions bought go into plants already operating one or more variable-speed drives.

Some Applications

In illustration, it may be interesting to cite a few representative applications of variable-speed drives and review briefly the problems involved and the advantages gained.

Continuous assembly conveyors as used by automobile manufacturers are responsible for a part of the surprising values we get in motor cars. Both trunk line and artery conveyors must be timed as closely as the moves in a football shift play. Materials must be collected and sub-assemblies made and delivered to the

main assembly line at exactly the right time. Variable-speed drives permit the final adjustment of speeds that make the system click. In one case the speeds range from 6 to 30 ft. per min., any speed within the range being instantly available.

Continuous heat-treating furnaces consist of slow moving conveyors to carry such metal parts as automobile springs, forgings, castings, chain pins, etc., through high-temperature furnaces. Ordinarily the tempera-

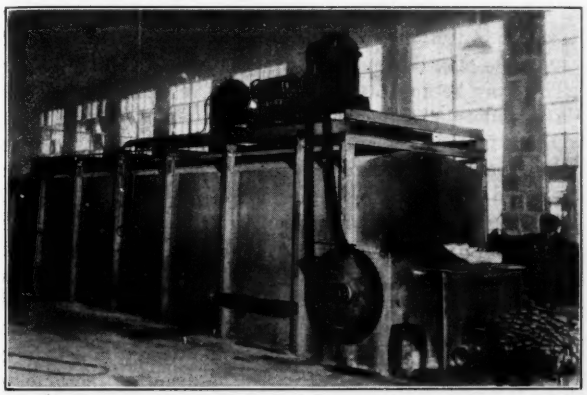

FIG. 2. HEAT TREATMENT OF AUTOMOBILE SPRINGS VARIED WITH SIZE

tures can be varied in different sections of the ovens, so that a part to be hardened or tempered is gradually heated, kept at a certain heat and cooled as it is carried from one end of the conveyor to the other. Here, the variable-speed drive can be adjusted to exactly the right speed for each kind of part being treated, slow speeds for large parts and increased speeds for runs of smaller parts. One continuous furnace, Fig. 2, for treating automobile springs has a speed range of from 0.9 to 4.5 ft. per min. and has been operating 24 hr. a day for over two years.

Glass annealing conveyors or lehrs are similar to the heat-treating ovens for alloy steels. The brittle glassware from the blowing machines must be brought to cherry heat, held for a certain period and cooled for packing before it reaches the discharge end of the conveyor. Here is another case where the conveyor speed must be variable, if different kinds of ware are to be handled. Heavy glass caskets take longer to heat and to cool than light drinking glasses and require much slower speeds. One glass plant on the Pacific coast, Fig. 3, has six lehr conveyors, the speed of which can be graduated from 2 to 10 in. per minute.

Several machine tool manufacturers are now equipping some of their machines with variable speed-drives to replace back gearing and step cone pulleys. The advantage claimed is that the cutting speed can be adjusted to the most economical point for the piece being machined. Speeds can be increased or decreased, depending upon small or large diameter, light or heavy, rough or fine cuts and the material being machined.

Food products manufacturers are large users of variable-speed speeds. One meat packer has one speed transmission which he uses whenever a new product is being put into production. He experiments with different cooking speeds until the ideal speed is determined, when a constant speed drive is designed and the variable-speed transmission is used on the next process. In smaller plants where several seasonal products are made, the variable-speed drives are permanent, as no two foods require the same processing speeds.

These applications and examples could go on world without end, but they simmer down to the following points in favor of the variable-speed drive:

1. A better or, at least, a more uniform product.
2. Increased production from the same machines, operators and power requirements.
3. Lower power costs.
4. Greater adaptability and more uses for the same machines.
5. Elimination of time lost in experimenting with drive speeds.

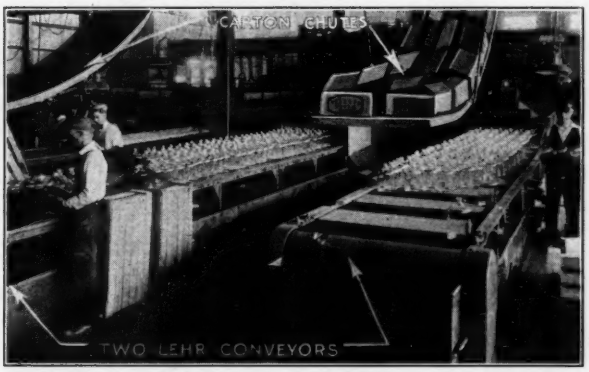

FIG. 3. GLASS BOTTLE TEMPERING IS EASILY CONTROLLED

Last but not least, greater effectiveness of plant for the executive in charge of production and of power using machinery.

STEEL FROM THE electric furnace is almost free from oxides and impurities. During the process, metals are fused by means of a practically enclosed arc and without contact with the air. After pouring, castings begin to solidify at the point farthest from the metal gate or riser, so that the shrinkage-head or riser acts as a reservoir and partially drains itself by supplying metal to take up the shrinkage as the casting solidifies in the mold.

This allows a more gradual cooling because of the greater mass of metal and also allows gases, slag or sand a better chance to get free of the casting. Good castings demand carefully dried molds and well made, well placed cores made with a good binder and from special sand properly baked. Because of shrinkage, patterns are made larger than the desired casting, the pattern maker using a shrink rule which is ⅛ in. per ft. longer than the standard foot measure for cast iron.

PRODUCTION OF ELECTRIC POWER by public utility power plants in the United States, during January, 1930, as reported by the Geological Survey, Dept. of the Interior, amounted to 8,647,373,000 kw-hr. an increase of 5 per cent over the production for January of last year. Of this amount 5,747,518,000 kw-hr. were made by fuel and the remainder, 2,899,855,000 kw-hr. by water power.

Routine for Lubricating Systems

DEFINITE RESPONSIBILITY, USE OF DIFFERENT SYSTEMS AND RECLAIMING OIL ENSURE ECONOMY. BY HERBERT L. SCHULTZ*

OFTEN, THE IMPORTANCE of proper lubrication is learned only through costly experience from neglect. It is indeed strange but true that the man who would not think of running his automobile with the oil gage reading half-full, to say nothing of an empty crankcase, becomes wholly indifference toward lubrication of plant equipment, which has the same vital need. The lubricating problem confronting management and those responsible for efficient plant operation is, therefore, to provide not only the most suitable lubricants and lubricators, but also systematic routine and means to make lubrication effective. One may step into almost any plant, even where this problem has been given considerable study and attention, and find that much can be done to improve this phase of industrial routine.

Where lubrication is given due consideration, it means longer life of equipment, consequently lower maintenance and repair bills. This also brings about lower unit costs as well as higher efficiency, in that available energy, otherwise wasted, is converted into useful work.

TYPES OF LUBRICANTS

Although it is not the purpose of this article to discuss the chemistry or theory of lubrication, they are major factors and must be looked upon as such. The day is long past when one or two oils and greases should be used for an entire plant's equipment. Lubricating technologists and research in this field have kept pace with ever-changing machinery and demands for lower unit costs.

When new machinery is purchased and installed, the manufacturer's instructions for its lubrication can generally be followed with confidence that the best results will be obtained, but not always. The writer's attention was recently called to a piece of equipment that failed, due to improper lubrication. Investigation disclosed that, in this case, the manufacturer's instructions for lubrication were carried out to the letter but atmospheric and operating conditions were such that an entirely different schedule had to be worked up.

In many plants, the nature of the product may offer serious objections to carbon and other base deposits left by some oils, depending upon their origin and location. This may be a paramount factor in selecting an oil with a paraffin or asphalt base, an eastern or western oil. Other factors bearing upon the selection of an oil are temperature, abrasive dust, gases, acid or alkali in the air and many other conditions.

Much discussion has been given to the question of whether oil or grease is more efficient and suitable for certain purposes. The latter is more viscous and will, in many instances, prove satisfactory where an oil would not, particularly where oil contamination might be detrimental to the product. The design and type of bearing will, of course, often be the deciding factor here. In some cases, where a highly abrasive atmosphere exists, satisfactory results have been reported from using an oil as the lubricant with a heavy grease on the ends of the bearing, as a protection against grit.

Most reputable oil companies have, as a part of their organization, an efficient service department the purpose of which is to coöperate with industry in providing the most suitable lubricants for its many needs. As a part of this service, trial samples are gladly submitted where recommendations are followed. Trial runs should be tabulated and recorded for current and future reference, as outlined in detail later in this article.

TYPES OF LUBRICATORS AND AUXILIARIES

Proper lubrication calls for the complete separation of wearing members by a continuous film of oil or grease as the case may be. This must, therefore, be the final objective in the selection of lubricators and their auxiliaries as well as lubricants. Over lubrication is often just as serious as insufficient lubrication, especially where heat invites excessive carbonaceous deposits, resulting in wearing and seizing of bearings. Not only must scientific lubrication satisfy these demands but it

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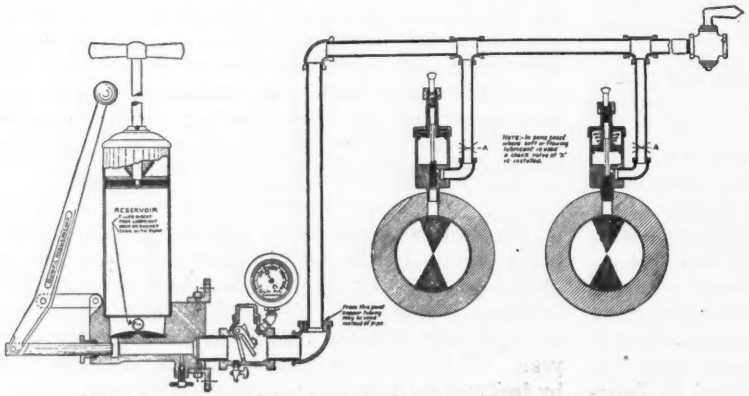


FIG. 1. PRESSURE SYSTEM TO LUBRICATE BEARINGS AUTOMATICALLY

FIG. 2. FORCE-FEED OIL CAN FEEDS ANY GRADE OF OIL AT ANY ANGLE

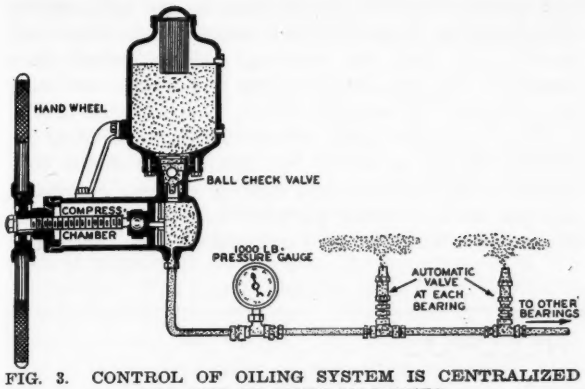


FIG. 3. CONTROL OF OILING SYSTEM IS CENTRALIZED FOR ONE OR MORE MACHINES

must also tie in with production and standard safety practice.

It is impossible within the scope of this article to present the entire range of development of modern lubrication, furthermore practically every plant has its own peculiar problems. This article would be incomplete, however, without emphasizing some of the outstanding advances that have been made along this line, with the purpose of bringing to mind that there is little excuse today for improper lubrication, regardless of the problem.

In a few instances, the old type of oiling and grease cup practice is still justifiable, where investment and wear involved do not justify more modern practice. On many machines equipped with simple construction of bearings, a wick or drop feed oiler is efficient where machines are running more or less continuously but, where operation is intermittent, they become inefficient as they will feed oil whether the journal is in motion or not. Under the latter condition, an Alemite-Zerk system often answers, where grease can be used as a lubricant.

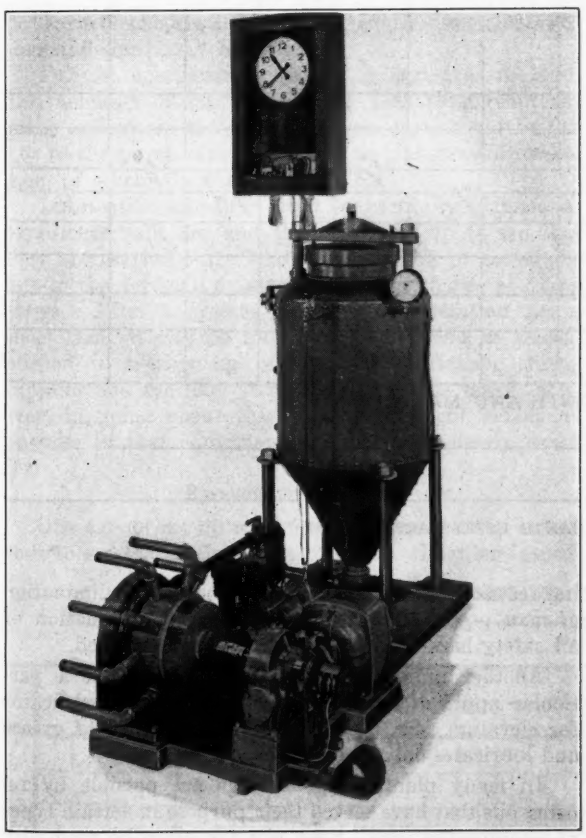


FIG. 4. TIME PERIOD OF LUBRICATION IS CONTROLLED FROM A CENTRAL POINT BY THIS SYSTEM

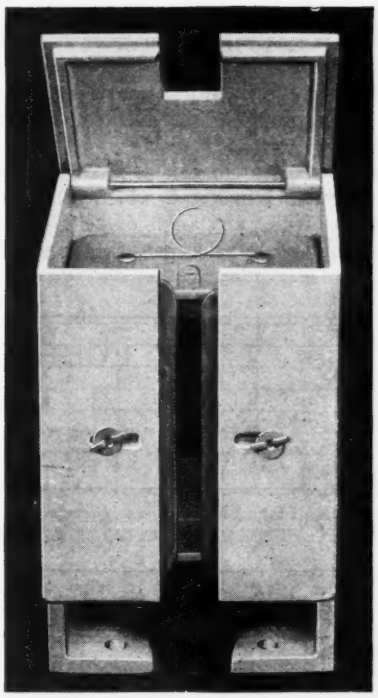


FIG. 5. ELEVATOR GUIDE RAIL LUBRICATOR FEEDS ONLY WHEN CAR MOVES

Central Systems

Several automatic and semi-automatic systems that have well proved their worth are now on the market. Figure 1 illustrates the principle and application of the Gun-Fil Corporation's system, with controlled feed lubricator to ensure lubrication to all bearings and elim-

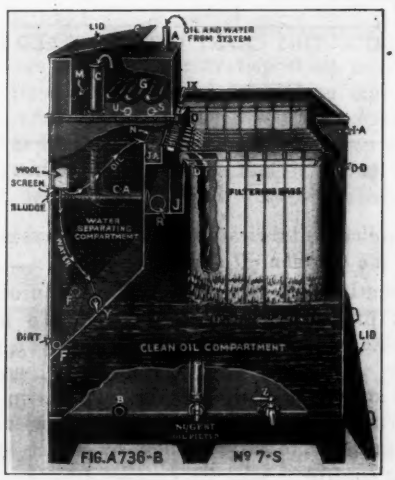


FIG. 6. THIS FILTER REMOVES DIRT AND WATER FROM USED OIL

inate loss in production. The unit feeders may be filled by any pressure system. A lubricator such as this may be manually controlled or made to operate automatically, driven from the machine upon which it is installed. Position of the spindle in the oiler controls the feed to each bearing.

Another convenient auxiliary piece of equipment is the pistol oiler shown in Fig. 2, which will operate under pressure when held at any angle or position. The trend of development and improvement is not confined to the more complicated lubricating devices but extends to the simplest, the common oil can.

Frequently the least contamination of product by a lubricant presents a serious problem. To meet this, along with greater economy and continuity of operation, a number of methods and systems have been devised. Figure 3 shows the Farval Central system in diagram, by which a predetermined amount of lubricant is fed at high pressure to all bearings, by either manual or automatic control.

Where requirements are exacting, the Pneuma-Lectric system, a recent contribution to the advancement of lubrication is particularly adaptable to large unit installations such as printing presses, which have numerous and intricate bearings and where continuity of operation is a deciding factor. As indicated in Fig. 4, this is a system piped to bearings from a central distributor which is driven by means of a motor compressor. An electric clock timing element automatically sets the lubricating periods whether the demand be every few minutes or once in several hours. Outstanding features with this type of lubricator are elimination of man power and the human element, elimination of all safety hazards and savings in lubricant used.

Another individual lubricator of merit for a particular application is the Zenon Guide Rail lubricator for elevators, Fig. 5, which holds about 2 lb. of grease and lubricates only when the car is in motion.

In many plants, large savings are possible by reusing oils that have served their purpose in certain types of machine bearings. Such oils can often be used with entire satisfaction on line shaft bearings and other

LUBRICATION RECORDS

MONTHLY SUMMARY

NAME_____

LOCATION_____

MONTH OF_____ 193__

		CONSUMPTION OF LUBRICANTS BY DEPARTMENTS OF PLANT									TOTAL
BRANDS OF LUBRICANTS											
CONSUMPTION	OIL GALS										
	GREASE LB										
PRODUCTION											

NOTE: THIS CHART IS TO BE FILLED IN EACH MONTH AND MAILED TO THE

_____

FIG. 7. SUMMARY OF LUBRICANTS USED EACH MONTH

places. For this purpose, there are available many automatic oil filters and purifiers, a Nugent stationary type being shown in Fig. 6.

Efficient Lubricating Routine

It must be conceded that the routine for efficient lubrication in any fair-sized plant is of no small importance. An effective system cannot be planned hastily and then handed to some subordinate to carry out.

Many large industrial establishments have found that it pays well to delegate the supervision of this routine to a lubricating engineer who has a knowledge of refining and compounding. Where size of plant and investment will not warrant this, the services are available of the various large oil companies, who send lubricating engineers into the field for the purpose of surveying a plant, recommending a standard of practice and assisting in setting up a system that will meet the particular requirements. With this data in hand, the responsibility of its supervision may be passed to one of the plant engineers, along with his regular duties.

In too many instances, new equipment is purchased with no thought given to lubrication until after its installation. The engineer or plant executive responsible for lubrication supervision should have a voice in such selections whenever possible, in order that the proper facilities may be provided and arranged for. Coördination should also exist between design and drafting divisions and this department, if costly alterations and failures due to improper lubrication are to be forestalled. Where lubrication is given careful attention, it will be found that much of practical value can be learned which will aid in the proper design of bearings and equipment in general.

Definite specifications should be issued as to kinds and amounts of lubricants to be used throughout the plant and where to be used. In no case should this be left to the purchasing agent and to high-pressure salesmen, of whom there are many.

Lubrication schedules must be carefully planned as experience calls for and then followed up to see that they are carried out. The details should, of course, be left to the foreman or man directly in charge of oiling crews. After a system has been in operation for a short time, it will be found that much can be accomplished in setting up budgets for lubricants, waste, supplies and the like. Great care must be taken, however, in going about this, otherwise it will defeat its purpose in that equipment will be inadequately cared for.

Records Are Needed

One cannot set up a system and then leave it to the gods to see that it functions properly. Regular inspections must be a part of the program. Even where central automatic and semi-automatic lubricators are in use, failures will occur, some bearings being flooded at times and others receiving no lubrication. The human and time elements can best be dealt with by close supervision and inspection.

LUBRICATION RECORDS
YEARLY CHART

MACHINES

	CONSUMPTION OIL GAL.	CONSUMPTION GREASE LB.	COST	PROD. TONS	COST TON	CONSUMPTION OIL GAL.	CONSUMPTION GREASE LB.	COST	PROD. TONS	COST TON	CON
JAN.											
FEB.											
MAR.											
APR.											
MAY											
JUNE											
JULY											
AUG.											
SEPT.											
OCT.											
NOV.											
DEC.											
TOTAL											

FIG. 8. THIS RECORD SHOWS YEARLY CONSUMPTION AND COST FOR EACH MACHINE OR DEPARTMENT

No plan devised will be effective unless records and statistics are kept. An up-to-date file should be collected of lubrication literature and educational data of interest to the particular industry involved. Charts similar to those shown in Figs. 7 to 9 will reveal to an executive just what is happening and what results are being accomplished. A chart similar to that shown in Fig. 9 may also be altered and made suitable for special trial and comparison test runs, although a simple card index file will often suffice for this and the inspection follow up.

As in all purchasing, it will be found that price is not always the criterion. The writer has been running tests on two particular lubricants which to date are proving identically satisfactory. They check up in chemical analysis, yet one is less than one-third in price of the other.

Oil House and Crew Management

No factor is perhaps more important in connection with effective and economical lubrication than good oil house and crew management. It is the practical end of all that has been said. When properly carried out, it means a minimum of storage and handling facilities, less labor, less lubricants and waste. Cleanliness and

LUBRICANTS USED
Month-------- Year ---------

Symbol	Lubricant	Used on	Aver. Price	Total Value	Remarks

FIG. 9. RECORD SHEET FOR DAY, MONTH OR YEAR OR FOR COMPARATIVE RUNS

elimination of contamination are impractical unless the responsibility for this is seriously recognized here.

Carelessness has no place in this routine. Responsibility or an understanding must exist covering lubrication in every nook and corner of the plant. Recently, my attention was called to a machine where this fixed responsibility had been placed upon nobody; in this case, a complete overhauling of the equipment was required, all because of neglect. In another instance, an oiler had been supplying grease for sometime to a grease cup which had been placed in error, over a packing gland, the bearing itself receiving no lubrication whatsoever.

Great care should be taken to see that storage cans are properly labeled. I recall one incident where an incorrectly labeled container filled with linseed oil nearly cost a company several hundreds of dollars. No amount of engineering and planning will offset carelessness of this nature; the latter simply cannot be tolerated.

Auxiliary equipment required by the lubricating department will, of course, vary with size and type of plant under discussion. In general, it should be properly equipped with cans for current storage, waste and oil carriers, grease guns, pressure lubricators and hand oilers. Since much of the cleanliness of equipment depends upon the oiling crew, pans should be supplied for bearings requiring them.

For hanging under shaft hanger bearings and the like, a funnel or pail shaped affair with drain cock has many advantages over the ordinary rectangular pan, as it will not tilt or fall so as to cause a possible injury and it can be easily cleaned. Hazards should be eliminated wherever practical. Hose and pipes should, therefore, be used for feeding lubricants to dangerous or hard-to-get-at bearings. It is false economy to omit safety platforms where needed, also ladders equipped with good safety shoes.

Where a considerable number of men make up the oiling crew, it is well to switch them around occasionally so that each oiler will be quite familiar with the equipment and its requirements in several departments. This will make possible the doubling up of several departments when it is found necessary to cut down the number of men in the gang during any long lull in production. But it is not always advisable to lay off oilers who have been a long time in training, at the first sign of letup in plant operation. Often this is the only time available for thoroughly cleaning and blowing bearings and motors, making minor repairs and carrying out inspection schedules.

Pipe-Joint Compounds

THE SHELLAC type of pipe-sealing compound will prove most satisfactory, if made according to the following formula: Wood or denatured ethyl alcohol, 1 gal.; orange shellac, 4 lb.

Mix the shellac and alcohol together with the aid of heat. Do not heat in an open container with a direct flame because of the inflammability of alcohol vapors but, if at all possible, heat under a reflux condenser in order to prevent their escape.

For the graphite type, an effective pipe-sealing compound is made by mixing together cylinder oil, linseed oil, soya bean fatty acids and graphite in the following percentages: Steam-refined cylinder stock, 65; linseed oil, 5; soya-bean fatty acids, 5; graphite, 25.

Heat the oils, then add the graphite, stirring constantly until the mixture is homogeneous.

Compound made according to the following formula is suitable for sealing pipes, for stopping small leaks in tanks and especially for use on high-pressure oil lines and equipment where particular care must be taken in sealing joints and where, the seal, once made, is thereafter quite often subjected to high temperatures: Denatured alcohol, 7.5 lb.; orange shellac, 7.5 lb.; hard rosin, 5.0 lb.; calcium sulphate (gypsum), 0.5 lb.; iron oxide, 3.7 lb.

This makes a little over a gallon, but the amounts should be weighed, not measured.

Dissolve the shellac and rosin in the alcohol; then mix in the calcium sulphate and the iron oxide, these latter ingredients both in finely divided form. Heating and agitating, preferably under a reflux condenser to prevent the loss of alcohol, are almost essential to obtain a uniform mixture.

Denver, Colo. H. L. KAUFFMAN.

Cork as a Noise Eliminator

VIBRATION of power plant machinery sometimes causes undesirable noise and distress. In order to avoid this vibration, a certain concern used a foundation so heavy that the comparatively small machine was unable to cause the heavy mass to vibrate. This machine was on a second floor and its foundation was of lead. The method worked but there are two objections to it. First, it is expensive; second, it is sometimes impossible to increase the bearing load on a second floor without adding reënforcing columns underneath. It so happened in this instance that additional columns were not required.

Elimination of vibration is best accomplished, I believe, by the use of cork board. Do not distribute the weight, however, over too large an area of cork or the amount of compression will be insufficient. Sometimes heavy concrete foundations are poured directly on top of cork board and the sides of the foundation lined with cork of proper thickness and density. The weight of the foundation plus the weight of the machine should be such as to give the cork the proper amount of compression. Vibration is thereby eliminated. Cork board is ideal for this purpose because it is strong in compression, highly elastic, surprisingly durable and does not rot. Cork, being light in weight, has a great advantage for use on second floors.

Cork is an excellent medium for eliminating machinery vibrations for the same reason that it is used for bottle stoppers; it is elastic, does not pack down, harden or lose its resilience. It is permanently strong in structure, easy and inexpensive to install and is moisture proof.

Newark, N. J. W. F. SCHAPHORST.

FEBRUARY SHIPMENTS of domestic water softening apparatus, as reported by 21 manufacturers to the Department of Commerce, were 1141 units, with a net sale price of $132,057, as compared with 1240 units in January, with a net sale price of $147,149, and 1506 units in February, 1929, with a net sale price of $136,713.

Insulation of Coolers in the Packing Industry*

INSULATING MATERIAL IN INDIANAPOLIS PACKING PLANT STILL IN GOOD CONDITION AFTER YEARS OF SERVICE

IN THE MEAT PACKING industry, the need for proper insulation for maintaining low temperatures is well recognized. Present day ideas of insulating freezers and coolers, however, are far different from what they were in 1863 when Thomas Kingan first conceived the idea of applying mechanical refrigeration to the cutting, curing and packing of meats. The idea of artificial refrigeration was successfully carried out under his supervision, making it possible to conduct slaughtering and packing the year around whereas, prior to this time, the packer could operate only in winter months. This development was a tremendous factor in the growth of the meat packing industry.

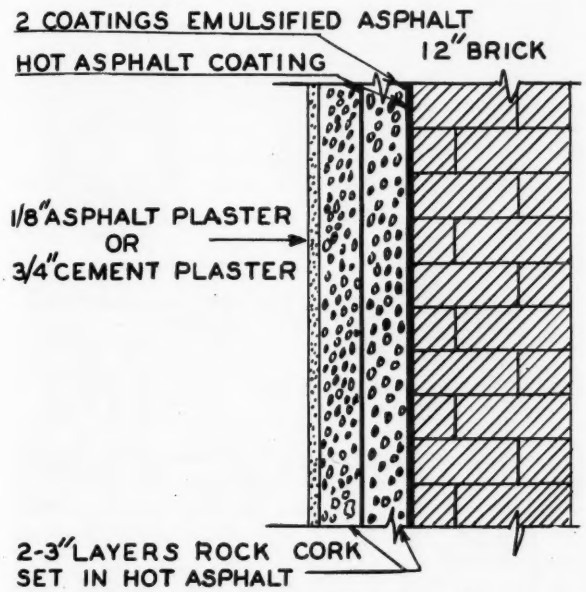


FIG. 1. TYPICAL OUTSIDE WALL CONSTRUCTION DETAILS

It is significant that today Kingan & Co., with headquarters in Indianapolis and branch plants throughout the United States, as well as selling connections in nearly all foreign countries, today stands as one of the nation's largest meat packers.

This concern early recognized the need for good insulation and in solving their problems they tried a variety of insulating materials. In 1913, rock cork was first applied. At this time, all the walls and the ceilings of the Ray Street plant which was constructed that year, were insulated with this material. This building is a brick structure about 175 ft. long and 125 ft. wide and has two stories and a basement, making a total of approximately 65,000 sq. ft. of floor space. It is interesting to note that the insulation put on over 16 yr. ago is still in excellent condition and that it has retained its original insulating properties.

*Abstracted from The Power Specialist.

Since that time, more of this kind of insulation has been used from time to time. Hog chill rooms, curing cellars, sausage rooms and beef coolers have been insulated with this material. At first, only the walls were insulated but later insulation was used in a number of the floors and ceilings of the various buildings.

In plants of this type, various ranges of temperatures are of course, required in a meat packing plant. In the freezers, the temperature desired is sometimes as low as 12 deg. F. but is usually maintained at about 0 deg. F. In the holding rooms, it varies from 10 to 15 deg. F., from 25 to 32 deg. F. in the sharp coolers and from 36 to 40 deg. F. in regular coolers. The temperatures are very carefully watched and controlled to meet exacting curing requirements. In some of the rooms, it is necessary to regulate the humidity. Automatic temperature and humidity control devices are used in various parts of the plant to maintain the required conditions. Several of the zero rooms have a south and

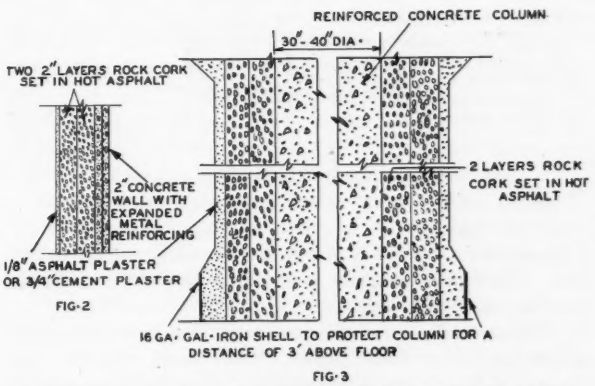

REINFORCED CONCRETE COLUMN
30"-40" DIA.
TWO 2" LAYERS ROCK CORK SET IN HOT ASPHALT
2" CONCRETE WALL WITH EXPANDED METAL REINFORCING
1/8" ASPHALT PLASTER OR 3/4" CEMENT PLASTER
FIG. 2
2 LAYERS ROCK CORK SET IN HOT ASPHALT
16 GA. GAL. IRON SHELL TO PROTECT COLUMN FOR A DISTANCE OF 3' ABOVE FLOOR
FIG. 3

FIG. 2. TYPICAL PARTITION CONSTRUCTION DETAILS
FIG. 3. COLUMN CONSTRUCTION DETAILS

west exposure, nevertheless there has been no trouble in maintaining the proper temperature. The credit for this is due to the proper design of the plant in the first place and then due to the fact that the insulation retains its insulating efficiency.

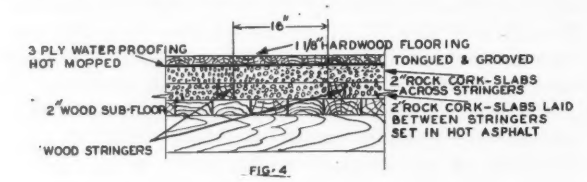
In the accompanying illustrations are shown the details of the wall, column and floor construction and the method of applying the insulation. Figure 1 shows the outside wall construction of the zero temperature freezers employed in a new building erected in 1924. It consists, as may be noted, of two coatings of emulsified asphalt placed on the brick wall over which is painted a hot asphalt coating. Over this are placed two 3-in. layers of rock cork insulation, these layers being separated by a hot asphalt coating. Over the rock cork is placed a layer of ⅛-in. asphalt plaster or ¾-in. cement plaster.

Where the temperatures required are not so low, two layers of 2-in. rock cork slabs in place of 3 in. were

employed. Figure 2 shows the typical construction of a wall partition. This also uses two 2-in. layers of rock cork set in hot asphalt, but where there is a large difference in temperature between the adjoining rooms two 3-in. slabs are used.

In Fig. 3 is shown the method in which the columns are insulated. These are of reinforced concrete insulated with two 2-in. layers of rock cork set in hot asphalt over which is placed a ⅛-in. layer of asphalt plaster or ¾ in. of cement plaster. In the zero temperature freezers, 3-in. slabs of rock cork were employed in place of the 2-in. The second layer of insulation is usually fastened to the joist with wooden skewers.

Figures 4 and 5 show two types of floor construction used at the Kingan & Co. plant. Figure 4 is for the typical wood construction and Fig. 5 for concrete. In the case of the former, 2-in. rock cork slabs are first laid between stringers set in hot asphalt. Over this, 2-in. rock cork slabs are laid across the stringers. This layer


16"
3 PLY WATERPROOFING HOT MOPPED
1 1/8" HARDWOOD FLOORING TONGUED & GROOVED
2" ROCK CORK-SLABS ACROSS STRINGERS
2" WOOD SUB-FLOOR
2" ROCK CORK-SLABS LAID BETWEEN STRINGERS SET IN HOT ASPHALT
WOOD STRINGERS
FIG. 4

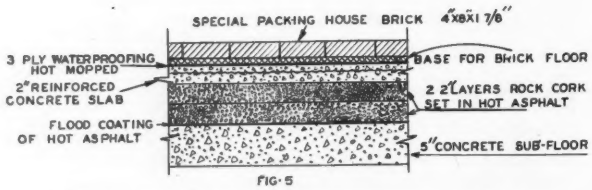

SPECIAL PACKING HOUSE BRICK 4"x8"x1 7/8"
3 PLY WATERPROOFING HOT MOPPED
BASE FOR BRICK FLOOR
2" REINFORCED CONCRETE SLAB
2 2" LAYERS ROCK CORK SET IN HOT ASPHALT
FLOOD COATING OF HOT ASPHALT
5" CONCRETE SUB-FLOOR
FIG. 5

FIG. 4. WOOD FLOOR CONSTRUCTION DETAILS
FIG. 5. CONCRETE FLOOR CONSTRUCTION DETAILS

is then covered with 3-ply water proofing, hot wrapped and this whole covered with 1⅛ hardwood flooring, tongued and grooved.

The insulation for the concrete floor construction is somewhat more complicated. This also employs two layers of rock cork over which a 2-in. reinforced concrete slab is placed. This in turn is covered with three-ply waterproofing and finally by a special packing house brick floor.

A ⅛-in. coat of asphalt plaster, or a ½ to ¾-in. coat of Portland cement plaster, is put over the rock cork in the walls and columns; it is not the general practice to score this. Both types of finishes serve very well. The plaster is painted usually with aluminum paint, to give all the rooms a neat and attractive appearance.

This method of applying insulation has proved very successful with this company. In 1924, another big building was added. This building, an 11-story brick and concrete structure, known as Building "U," was erected along the curve of a railroad siding, and hence is not a perfect rectangle. One side is 145 ft. long, another is 125 ft., the third is 63 ft. and the fourth—along the railroad siding—is approximately 165 ft. Rock cork, in thicknesses of 2 to 6 in., depending upon the temperature requirements of the rooms, was employed on all of the walls and columns throughout this building. A total of about 270,000 board feet of rock cork were used in the structure. It was not put in the floors and ceilings of this building because of certain structural problems.

A recent inspection showed that this insulation is also still in very good condition, after about 5 yr. of service. It is just as easy to maintain the proper temperatures today in the various rooms as it was when the building was erected.

New Vertical Unaflow Engine

FOR SEVERAL YEARS, the Skinner Engine Co. has been developing an improved valve gear that could be applied to a vertical steam engine of the unaflow type. The object was to develop a rotative valve gear that would have flat-faced cams and flat-faced rollers to minimize wear; that would also give constant lead, with a variable cutoff; and that would operate at comparatively high speeds. Constant lead is desirable with the unaflow cycle as the compression is constant and, therefore, the lead should be constant.

As finally developed, the engine is of the three-

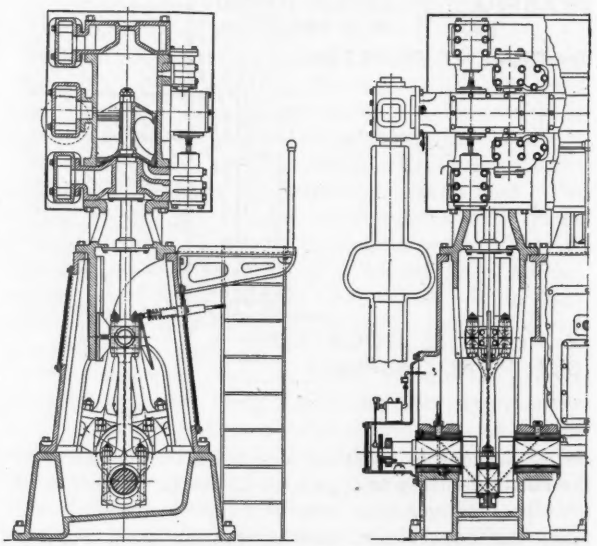


FIG. 1. SECTIONAL FRONT AND END ELEVATIONS OF 3-CYLINDER, VERTICAL UNAFLOW ENGINE

cylinder type, the cylinders being cast separately. It is equipped with expansion-compensating, double-seat poppet admission valves like those used on the horizontal Universal Unaflow engine. Auxiliary exhaust valves are of the single-beat poppet type, located away from the ends of the cylinder and are built to disengage automatically from their cams and remain closed for condensing operation.

Front and end sectional views are shown in Fig. 1. In order to overcome the packing and alinement troubles that sometimes develop where guides are attached to the side of the frame, due to the difference in expansion between the cylinders and the frame, each guide is integral with its spacer piece, which is mounted on top of the frame and supports the cylinder. Boring and facing are accomplished at one setting, so that the guide is always concentric and parallel with the cylinder bore.

Lower cylinder heads, space pieces and guide castings are permanently doweled together by concentric cylindrical fits, the alinement being checked before

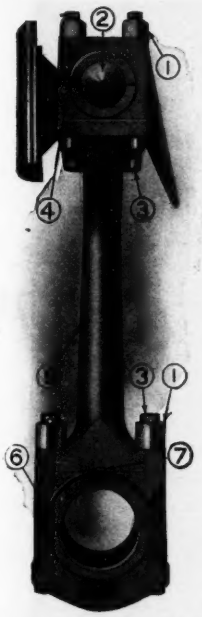


FIG. 2. CROSSHEAD WITH BORED GUIDE AND ATTACHED INDICATOR MOTION. CONNECTING ROD DRILLED FOR LUBRICATING CROSSHEAD BEARINGS

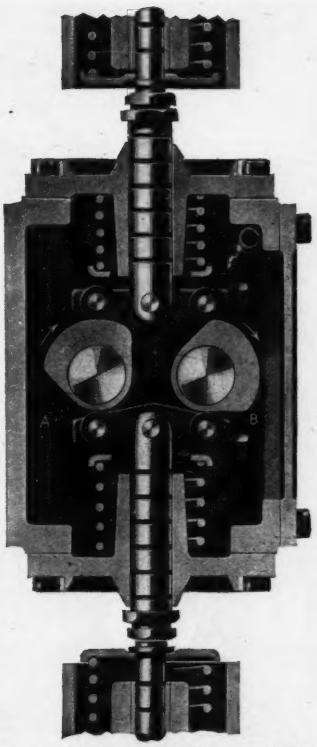


FIG. 4. VALVE OPERATION IS BY CAMS ON TWO SHAFTS

mounting the assembly in the engine frame. Instead of full bored guide construction, flat retaining guides are bolted to the sides of the main guide to hold the crosshead against the bored face.

Crosshead and pins, Fig. 2, are made from a single-piece forging. The piston rod is inserted but not screwed, into the crosshead and is made fast to the crosshead by a specially-designed lock nut. Figure 2 also shows the connecting rod construction, the rod being drilled throughout its entire length for carrying force-feed oil to the crosshead bearings, guide and shoe.

Four main bearings are provided, with short crank spans between each pair of bearings, for the three-throw crankshaft, each crank having a bearing on each side. The bearings can be easily removed by relieving the weight of the shaft from the lower half.

Two cam shafts, Fig. 3, are employed, on one of which are mounted the cams, A, for opening the admission valves and the cams, C, which operate the auxiliary exhaust valves. The second cam shaft carries the cams, B, for closing the steam valves. Shafts are carried in bearings, D, and ball bearings, E. Cutoff control is through a worm wheel, F, driven by the vertical centrifugal governor and drive of the other camshaft is by the miter spiral gear, G, which meshes with a similar gear keyed to a vertical driving shaft. All cams are duplicates, as indicated in Fig. 4, a cross-section of the valve gear. Shaft A is geared directly to the main shaft and, therefore, has a fixed angular relation to the crank shaft at all times. On it are mounted the three admission cams and the three cams which open and close the auxiliary exhaust valves, all cams being of simple tangential type. On shaft B, which runs in synchronism with shaft A but with a variable angular relation determined by the governor, are mounted the closing cams for the steam valves. If the governor advances shaft B, early cutoff results and vice-versa. This relation is accomplished by a simple pair of one-to-one worm gears, one of these being attached to the governor shaft and the other being mounted on shaft B.

Cams of simple tangential form and rollers are flat-faced to give line contact and construction of the valve gear is such that pressure between the roller and its cam is only one-half that required to lift the valve, which makes for long life with small thrust on the tappet, guide, governor and camshaft bearings.

All bearings, including the crosshead and guides, are lubricated by oil under pressure of approximately 25 lb. Oil from the valve gear returns through the governor housing to the crank case, lubricating all the governor parts and all vertical shaft bearings.

Mounted on the vertical cam-driving shaft, the governor has four fly-balls, instead of two, which doubles the centrifugal force and gives quicker response to sudden changes of load. The weight and thrust are taken care of by large ball and roller bearings.

Each engine is equipped with a device, by means of which the speed may be changed by turning the hand wheel mounted on the side of the governor housing, a simple and convenient method of synchronizing.

Cylinder lubrication is accomplished by an adjustable force-feed pump, having six feeds, forcing oil into each of the steam valve boxes, where it is atomized before being carried to the cylinders by the flow of steam.

Tappet adjustment is accomplished by removing three sections of the cylinder lagging seen in Fig. 5, without removing or changing the adjustment of any of the valve gear parts. Removable frame cover plates, Fig. 5, give access to crossheads, crankpins and main bearings, while the spacer head allows plenty of room

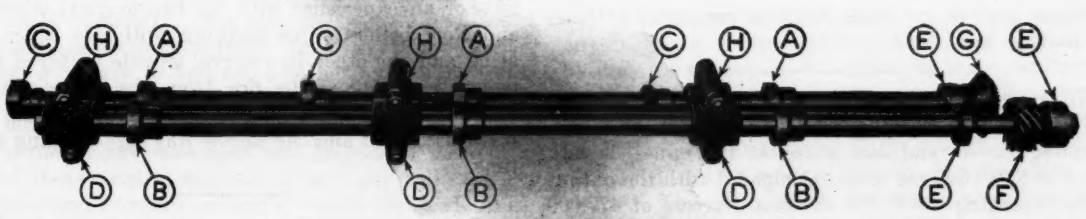


FIG. 3. CAMS ARE CARRIED ON TWO SHAFTS, ONE CONTROLLED BY THE GOVERNOR TO REGULATE CUTOFF

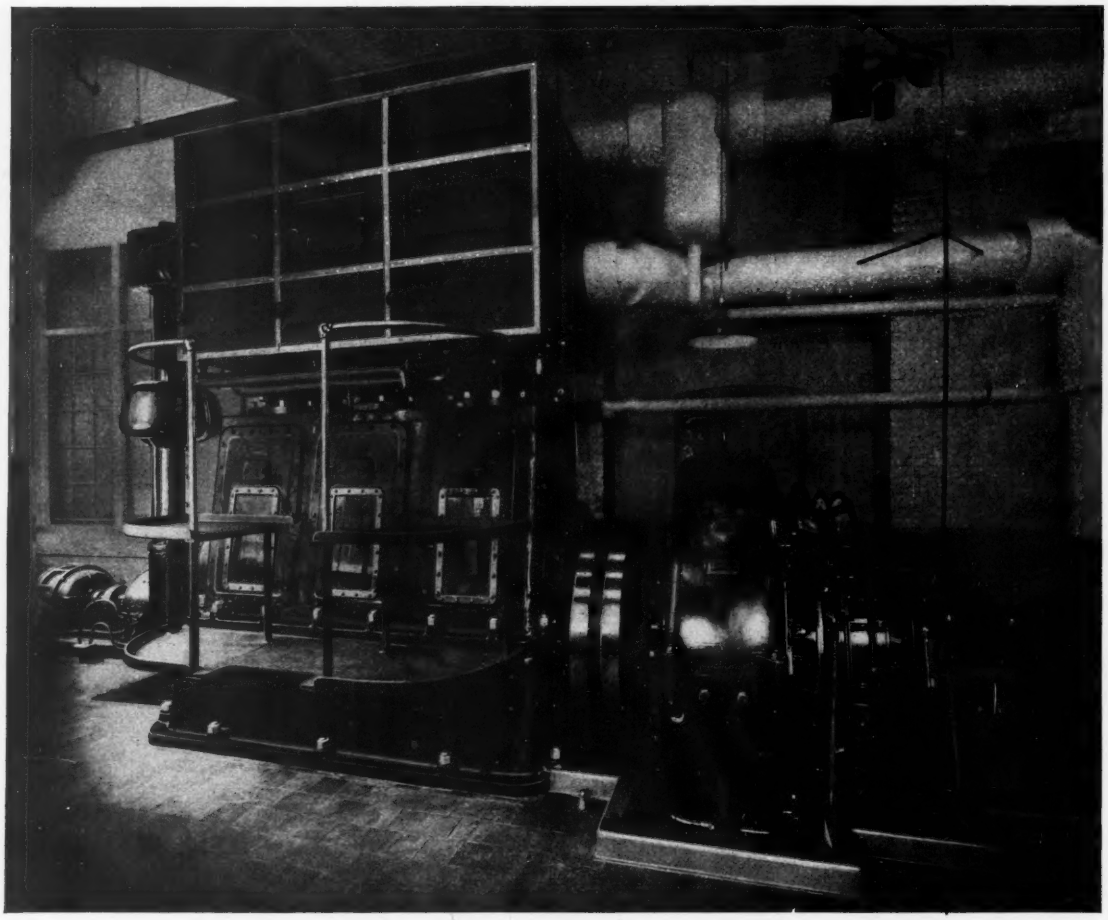


FIG. 5. SKINNER VERTICAL UNIVERSAL UNAFLOW ENGINE DIRECT CONNECTED TO GENERATOR

for adjustment or removal of the metallic rod packing; or the packing may be dropped down on the crosshead where it is accessible through the large doors in the main frame.

Economy is approximately the same as that of the Skinner horizontal Universal Unaflow engine. One purchaser, who keeps accurate daily records, reported that, for eight consecutive days (disregarding one Sunday, when the plant was closed down) his engine showed an average steam rate of 27.8 lb. per kw-hr., including the steam for boiler feed pump and stoker engine. The average steam conditions were 175 lb. pressure, 100 deg. superheat and 2 lb. back pressure. Inasmuch as the boiler equipment was showing an average evaporation of 9.55 lb., the coal rate per kilowatt-hour, including boiler feed pump, stoker engine and power plant losses, was 2.91 lb.

These engines are being built in capacities of from 200 to 1250 kw.

TOTAL PRODUCTION OF SOFT COAL during the week ending March 15, as reported by the Bureau of Mines, including lignite and coal coked at the mines, is estimated at 8,088,000 net tons. Compared with the output in the preceding week, this shows a decrease of 477,000 t., or 5.6 per cent. Total production of soft coal during the present coal year to March 15 amounts to 499,125,000 net tons.

Fred W. Deming Serves 40 Yr. in Same Engine Room

RECORD of long and efficient service as a power plant engineer has recently been established by Fred W. Deming of Willimantic, Conn. On Dec. 3, 1929, Mr. Deming completed 40 yr. of service in the same engine room. He is now 73 yr. old. His employment began with the W. G. and A. R. Morrison Machine Co. and, during the years that followed, seven different concerns have occupied the building, the present occupant being the Windham Silk Co.

Not once in all that time has Mr. Deming's engine, a Rollins, failed to start promptly at 7 a. m. The boilers serving it, however, have been replaced three times.

Typical of Mr. Deming's experiences is the story he tells of an experience with his two original Abendroth and Root boilers. One morning, with one boiler operating and the other in reserve, trouble occurred in the boiler feed pipe. The fire from the first boiler was promptly shoveled into the furnace of the second, steam was raised in it and the engine was kept running all the time.

ROTARY AND GEAR pumps are used extensively for pumping lubricating oil and cooling water for steam and internal combustion engines.

Superheater Element Leaks

PRACTICALLY every power boiler today is equipped with a superheater which, like every other piece of power apparatus, must be expected, sooner or later, to require repairs such as of leaky elements.

In one U-bend type of element, having an internal closed steel tube, small steel, rivet-head shaped supports

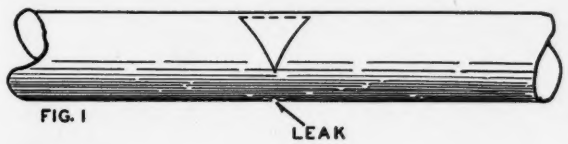


FIG. 1

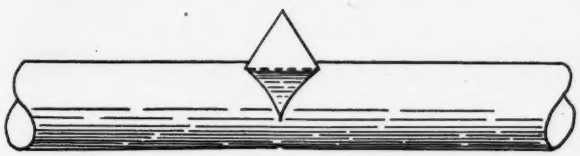


FIG. 2
WELDING LEAKY SUPERHEATER FROM THE TUBE INSIDE

are used to keep this tube in the center of the superheater element. In many plants, where the superheater inspection does not show the necessity of internal cleaning, it is rarely that all these internal tubes are removed. After 5 to 10 yr. of service some one of these rivet-head shaped supports, due to the constant vibration of the internal tube, will wear a pin hole through the bottom of the superheater element. Removing the leaky element and replacing it with a new one or plugging the ends of the element from the inside of the two superheater headers is a long, tedious and expensive job.

Superheater element repairs of this kind made by the writer with the use of an acetylene torch have been uniformly successful. Not one such repair has leaked or shown any signs of distress. In a smooth tube superheater, it is easy to find the hole but on a superheater with cast iron corrugated rings it is more difficult. In the latter case, the leak will usually show up where two of these rings come together. In making the repair, one of these rings at the leak is carefully split along a diameter and removed so that it can be replaced. With the use of an acetylene torch in the hands ot an experienced welder, using the finest cutting tip possible, two sides of a triangular flap are cut on top of and towards the side of the tube above the leak as shown in the accompanying sketch, Fig. 1. The third side of the triangle is then heated to a cherry red and the flap bent up as shown in Fig. 2. This opening will be of sufficient size to allow the torch tip and steel rod to be used to weld the hole in the bottom of the tube from the inside. Then the hinge of the flap is heated again, the flap bent over into its original place and both sides of the flap welded from the top and outside of the tube.

If there is no leak after a pressure test, the cast iron with the torch on both sides where it was cracked on corrugated ring can be refitted to the tube and caught removal.

It would be interesting if other readers would discuss their methods for care and repair of superheaters.

Somerset, Mass. WILLIAM H. BURTON.

Tri-Sodium Phosphate Controlling Boiler Concentration

TO THE MAN operating the small and moderate sized plant, the problem of keeping boilers clean and operating is generally a pertinent one, first because he generally has no spare boiler capacity, second because he is generally short of help and third because he has no access to the services of a chemist to keep his boiler water conditioned.

Suppose we choose for discussion a plant using a lime-soda softener and turbines with surface condensers. In the first place, the probable hardness left in the water after treatment will be something over two gr. per gal., depending on the raw water contamination and whether the softener is hot or cold process. This hardness, after concentration, is sufficient to require periodical cleaning of boilers, even though there were no other source of contamination such as condenser leakage, which is always present.

Under these conditions, if we are to keep our boilers on the line a maximum time, something further must be done to the water to inhibit its scale forming tendencies. It is here that the average small plant operator is handicapped, although in most cases he can control his boiler concentration with the use of an additional chemical based on a few simple tests of the water in the boilers. This chemical is tri-sodium phosphate, which is put in solution in water and added to the boiler feed, after it has passed all sources of contamination. The most satisfactory way of adding tri-sodium phosphate

is to feed it to each boiler separately but satisfactory results may be obtained by feeding it to the heaters which is a simpler method because in this case we have gravity feed against little or no back pressure.

To illustrate the results that may be expected, let us take a concrete example of results obtained on four 3050-sq. ft. boilers operating at an average of 175 per cent of rating. The figures shown in the tests are all grains per gallon. These tests are the usual H or hardness as obtained with a standard soap solution, the Ph or phenolphthalein and the Mo or methyl orange. The formulas used are the standard alkalinity formulas for water as given below:

STANDARD FORMULAS FOR COMPUTING VARIOUS FORMS OF ALKALINITY PRESENT IN WATER

Ph Values	HCO_3 or Bicarbonates	CO_3 or Carbonates	OH or Hydrates
0	Mo	0	0
Less than ½ Mo	Mo-2Ph	2Ph	0
½ Mo	0	2Ph	0
Greater than ½ Mo	0	2(Mo-Ph)	2Ph-Mo
Mo	0	0	Mo

The following typical titrations are about average for the water under discussion:

	Raw Water	Treated Water
H	12.0	2.5
Ph	0.35	1.34
Mo	4.26	2.62

The indication on this treated water shows a minimum of treatment for the results obtained as evidenced by the following equations from the formulas in the preceding table:

Hydroxide (lime in this case)	= 2Ph-Mo	= 0.06
Total Carbonates	= 2(Mo-Ph)	= 2.56
Soda Ash	= 2(Mo-Ph)-H	= 0.06

This is generally considered fairly well treated water, although it may have been benefited a trifle by a small addition of both lime and soda ash. Such addition is, however, sometimes questionable with a water of this hardness from a cold process softener.

Before the application of tri-sodium phosphate, for further conditioning, the water in the boilers averaged about as follows: H = 3.73; Ph = 17.72; Mo = 19.76.

Hydroxide (sodium in this case from action of pressure and temperature on soda ash) = 2Ph-Mo = 15.68; total carbonates = 2(Mo-Ph) = 4.08; soda ash = 2(Mo-Ph)-H = 0.35.

Titration of water in boiler after the addition of phosphate:

H	Ph	Mo	OH 2Ph-Mo	CO_3 2(Mo-Ph)	Normal CO_3 CO_3-H
0.23	2.33	3.85	0.81	3.04	2.81

Normal CO_3 in this case is soda ash.

Before the use of tri-sodium phosphate in the plant above referred to, it was necessary to turbine the boilers every 90 days. Since using this phosphate, the amount of chemical, principally soda ash, used in the softener has been reduced enough nearly to offset the extra cost of the phosphate and none of the boilers have had to be turbined for 14 months. The boilers are in better condition, also, than when the treatment was started.

With this treatment, it is possible so to regulate the soda ash fed to the softener that the hydroxide concentration in the boilers can be held at a value that will inhibit corrosion and at the same time cause no embrittlement, even if the water carries a small amount of sulphate.

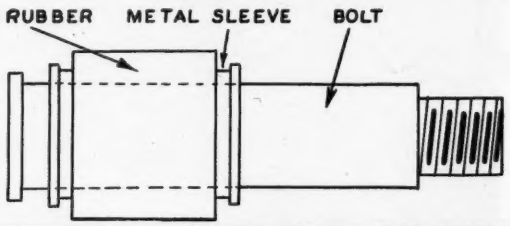
It is realized that all of these tests are not chemically exact but their indications are sufficiently accurate to enable the average operator to keep his boilers in excellent condition.

Chanute, Kansas. H. R. WILLIAMS.

Flexible Coupling Repair by Rubber Tube

RECENTLY A TURBINE-DRIVEN fan was installed to supply air for the underfeed stoker. It had been in operation not more than two months when the fireman reported that something was wrong with the coupling between the turbine and fan.

This coupling consisted of two special flanges held together by four bolts. The holes in the flanges were



RUBBER TUBING STRETCHED OVER SLEEVE CUSHIONS BOLT FROM FLANGE

large, each hole having a metal sleeve covered with rubber to keep the sleeve from coming in contact with the sides of the holes in the flanges. The bolts were slipped through the sleeves. This combination gave satisfaction as a flexible coupling.

When I investigated the trouble, I found the rubber covering worn so badly that the metal sleeves were in contact with the flanges. This was causing quite a noise and, if allowed to continue, would wear the flange holes out of round.

Remembering that I had a box of large rubber bands such as druggists use, I built up temporary sleeves of these rubber bands, as it was necessary to keep the plant operating.

Next day, I obtained a piece of flexible rubber tubing ¾ in. inside diameter, which, when stretched over the sleeves, held securely. Now, when the rubbers need replacing, I simply cut off 1½-in. lengths for that purpose. The work and cost of replacement are trifling.

Brockton, Mass. COLEMAN WINCHESTER.

Diesel Engine Needle Valve Upkeep

DIESEL ENGINE needle valves need careful grinding in order to render them oil tight and great care must be taken, when grinding, to avoid forming a recess in the valve or its seat.

Use of hard abrasives such as powdered emery is inadvisable. The best method of grinding in is to re-

move the valve, clean it thoroughly and put a film of oil on its bearing surface. The valve should then be replaced on its seat, given a few turns and then withdrawn, after which the condition of the seat can readily be seen, any high spots showing up plainly.

Such high spots should be rubbed down with a dead smooth file so as to make the valve surface as nearly true as possible. Next some metal polish should be put on the valve seat and the valve ground in as usual. This operation should be continued until a polished surface is seen over the entire valve face. Gas tight surfaces may then be attained without wearing away much metal but it takes longer than grinding in by coarse abrasives. Unless great care is taken when grinding in with coarse abrasives, a recess is liable to be worn in the valve seat which, under operating condition of the engine, may require the fuel valve to be lifted clear of this recess before the full amount of fuel can flow, hence engine power will be lost and the engine made more difficult to start.

If a valve seat is thought to be in this recessed condition, it may be tested by a candle which should be warmed until the wax is soft, after which it should be pushed on to the valve seat. The candle should then be withdrawn and if it were soft enough, a true impression will be made of the valve seat. If a valve seat is badly worn, the only remedy is replacement.

Brighton, England. W. E. WARNER.

Corliss Valve Setting Without Indicator

IN SETTING the valves on a Corliss engine where an indicator is not at hand, one thing that often causes some worry is to set the governor for the proper cutoff. After valves are set, block the governor at the height that it would ordinarily operate when carrying its rated load. Then disconnect the valve motion from the connecting rod of the eccentric and move the wristplate by hand with the starting bar, as slowly as possible, having an attendant measure with sharp-pointed spring dividers the distance that the wristplate is moved before cutoff occurs. Then move the wristplate in the opposite direction until cutoff occurs and in this way the cutoff can be set almost as evenly as is possible with an indicator. Cutoff can be set for any portion of stroke, ¼ or 1/3, or whatever the load conditions may require.

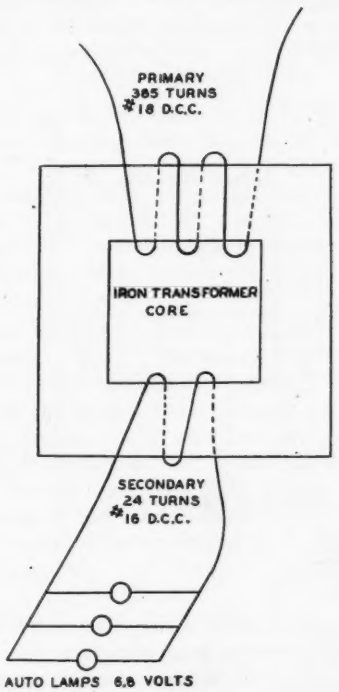
Kansas City, Kansas. J. F. STALEY.

Electric Lights for Safe Use in Boilers

ENGINEERS AND FIREMEN, who are obliged to enter boilers and furnaces for inspection and cleaning purposes at regular intervals, often take chances in using an ordinary extension cord attached to the 110-v. lighting circuit in the boiler room. As the boiler is thoroughly grounded, any damage to the insulation of the extension cord presents a hazard to the man handling it since his clothes and shoes are usually damp. On numerous occasions, men have been killed by potentials as low as 110 v.

Dragging the cord over the rough edges of manholes soon damages the insulation. To avoid this source of danger, a small transformer can easily be built by the average mechanic employed in a power plant. The material required is readily procurable from discarded parts that will answer admirably. The transformer core should contain approximately 2 sq. in. of iron laminations. The dimensions may vary considerably, so some old transformer core, that may happen to be available, will usually answer the purpose. The primary coil should be well insulated from the core by covering it with varnished cambric or fish paper such as used by armature winders. Instead of double cottom covered wire, one may use single cotton covered enameled wire.

Ordinary automobile lamps can be arranged in a cluster and protected from damage by wire netting. With this arrangement the user takes no chances. The transformer, which should remain outside the boiler, may be attached to the 110-v. circuit by means of a piece of drop cord. The cord on the secondary side



WINDING AND CONNECTIONS FOR TRANSFORMER TO PROTECT USER OF EXTENSION ELECTRIC LINE

of the transformer should be long enough to allow the low voltage lamps to be carried to any part of the boiler.

Cold Spring, Minn. CHAS. A. PETERSON.

Chain to Remove Tuyere Rods

RODS WHICH HOLD in place the tuyere blocks of underfeed stokers sometimes become fast so that they are difficult to remove when replacement of a tuyere block is necessary.

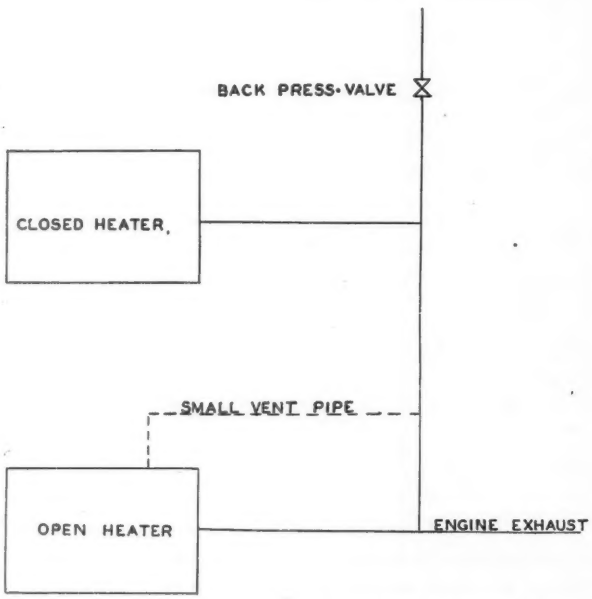
Removal of such rods may be easily accomplished by fastening an 8 or 10-ft. chain to the rod by means of a bolt through the eye of the rod. Holding the other end in the hand when the chain is slack, a snapping motion given to the chain quickly causes the rod to loosen. Rods have been pulled in this way when all other methods have failed. The rod will bend under the treatment it receives but not so badly that it cannot be straightened with a hammer in a few minutes.

Minneapolis, Minn. FRED S. RUTLEDGE.

Questions and Answers

Steam Savings from Changed Installation

ON PAGE 250 of the February 15 issue H. W. B. presents a nice problem but there is hardly sufficient data to do any more than suggest where he might look for a solution. He does not state what the amount of water



PROPER METHOD OF INSTALLING OPEN HEATER, IN CONNECTION WITH CLOSED HEATER, TO THE LINE

evaporated was before the change but I am of the opinion that it must have been more than the present total of 6750 lb. per hr. Also his make-up must have decreased, due to prevention of the loss caused by escape of the cloud of steam coming from the exhaust. Few small plants are equipped to give information regarding the amount of water evaporated and I take it for granted that such is the case with H. W. B. Had he equipment for this purpose, there might be no problem.

It seems to me that H. W. B. figures his new feed temperature incorrectly because only 60 per cent of the feed has an increase while the other 40 per cent has a decrease of 20 deg. so that his total increase is nearer 70 deg. than 110 deg. This leads me to think that he must have been blowing steam directly from his machines into the heater either through leaky traps or untrapped lines, otherwise the heater should still be able to heat the water to 210 deg. as the amount of exhaust available remains the same.

Heating savings accomplished by increase in feed temperature will account for about 1.5 t. of coal a week. This estimate will probably vary over quite wide limits in the different answers sent in but I figured it conservatively, making due allowance for the fact that this is a small plant, probably hand fired, and I believe my estimate to be about right.

So far we have something definite to work upon but the amount of steam used by the feed pump can only be guessed. Every one knows that the water rate for this type of pump is high and may, as the pump gets older and less efficient, run into almost unbelievable quantities. For this reason, I hesitate to make an estimate but will suggest that H. W. B. be sure that he is allowing enough on this item. I feel quite certain that he is going light on this rather than allowing too much.

Evidently, he has overlooked a point that I feel sure may have a bearing on the subject. This is the fact that he has raised his return line pressure and thus reduced the pressure differential on his traps. In the first case, his traps were discharging at 110 lb. press. against approximately atmospheric pressure. This water, being at the temperature corresponding to 110 lb. press., would flash into steam and considerable of the heat might be lost, if it was possible for that steam to be discharged, which seems to have been the case.

Should any of his traps leak, as many traps do regardless of how much care may be taken of them, this loss may be considerable. It only takes a few small leaks to lose heat amounting to a couple of tons of coal a week when there is enough difference of pressure. After the change, however, the traps discharge against a pressure much higher than atmospheric. In fact, it may be near boiler pressure and, judging from his illustration of the hook-up and the fact that the return temperature is so high, I should say that such is the case.

Due to this reduction of differential, his traps will tend to leak less than before and the leakage he does have will be less serious, for this steam cannot get out of the system and thus the heat will be regained.

Piping up of this heater would make it possible for the exhaust steam to pick up the water and carry it along, discharging it in spray form. This might have happened, particularly if the heater was rather small for the job and if the velocity of the steam was high. This condition might disappear after the change was made, as no flash steam would be present so that the back pressure valve would remain closed all of the time. With an open heater, a better practice is to pipe it more nearly as is his closed heater and vent the top back to the exhaust line or, if this is not practical, to the atmosphere.

After making a change from which savings are anticipated, everybody is likely to put a little more effort into his work and, while this may be done un-

consciously, it may have quite an appreciable effect on the result. This is noticeable on such occasions as boiler trials and is one reason that they do not mean so much in the last analysis as might be expected. Maybe, at present, just a little more attention is being paid to the firing or some other detail which might affect the efficiency.

Sometimes improved supervision is the result of an apparently chance word dropped by a clever salesman who is psychologist enough to know the power of suggestion and is, at the same time, engineer enough to see where things might be improved to the advantage of his product.

I hardly think there is any mystery about this problem but believe rather that H. W. B. is so close to his problem that he loses perspective. Probably an outsider could find the solution more readily than he.

The introduction of less make-up may lessen the scale and result in a cleaner boiler, so getting better efficiency but I would advise H. W. B. to watch his tubes and boiler shell for signs of pitting after his return traps have been in use for awhile.

Turners Falls, Mass. WILLIAM W. WHITE.

Refrigeration Regulation Improvement

REFERRING to A.A.A.'s request for information and to C. T. Baker's comments on page 304 of the March 1 issue, I believe the trouble lies in one or all of three conditions: Not enough ammonia in the system; second, air in the condenser through leakage of the compressor stuffing-boxes when operating under low pressure and third, no indirect expansion in the cold storage rooms.

With indirect expansion, one expansion valve will serve two or three rooms after the temperature has been brought down to the desired amount. No extra valve is needed in the main liquid line. The line should contain nothing but liquid up to the expansion valves; in order to get proper results. On the return gas line from the storage rooms, there should be a drip tank at the lowest point in the line to catch any oil or sediment before it goes to the compressor.

Taft, Calif. JOHN W. DAY.

Unusual Savings by Change in Installation

HAVING READ with interest the problem submitted by H. W. B. in your issue of February 15, I would offer the following explanation: In the final analysis, the difference in conditions which would influence the coal consumption is found in the note that under installation A a cloud of exhaust came from the back-pressure valve, which we may presume is a valve relieving the exhaust steam to atmosphere at a fixed pressure.

Exhaust steam is utilized only at the closed heater and in heating the boiler feedwater. But we find that the average temperature of all condensate if mixed in the open heater would be 275 deg., hence, instead of absorbing heat the mixture would give off its flash heat thus increasing the amount of exhaust steam in the system. The additional amount of pumping would require the use of approximately 700 lb. of steam per hr. from the pump, which would be totally wasted if all the exhaust is not utilized. Further, since in condition A the pressure of the exhaust system is such that it was relieved to the atmosphere through the back-pressure valve, while in condition B no exhaust steam was lost, we may presume a difference in exhaust pressure of the two systems of at least two or three pounds, which in turn would materially affect the live steam consumption of the main engine. This latter factor is apparently the deciding cause for the difference in coal consumption, the whole condition in turn being due to the difference in exhaust steam pressure under the two systems of hook-up.

Honolulu, P. I. WALTER E. SMITH.

Boiler Blowdown

I AGREE WITH R. W. Cater, page 75 of the January 1 issue, about blowing down boilers. It has been my experience that when you drain a boiler after cooling down for cleaning, it is always necessary, if there are many solids in the feedwater, to wash out the sediment with a water hose before going in the drum. Nearly all Insurance Inspectors require the boiler to be washed out before inspection.

Of course, scale forming solids will still remain. Ten years' experience has taught me to treat the water to get rid of scale-forming matter before it goes into the boiler, but in the smaller plants a large amount of mud that can be washed out is usually found in the water. My method of blowing down a banked boiler is to bring it to line pressure and then blow down. In the last plant I worked, I had remarkable success in overcoming a bad mud condition by operating as described.

Turtle Creek, Pa. JAMES H. COX.

WITH ALL DUE respect for a brother engineer's view on anything, I disagree with R. W. Cater on his contention regarding boiler blowoff. I have been experimenting for several weeks on this very subject and find I get less sediment his way than from any of my several other different tests. I have two horizontal water-tube boilers of the two drum type and get the best results by the following method:

My feedwater lines, one for each drum, enter the drums from the front and extend 18 in. beyond the front water legs or headers. After our plant shuts down at 4:30 p. m., I wait until the night fireman comes on at 6:00 p. m. and the feedwater pump is started, slowly pumping about a gage of water in the boiler. This has a tendency to settle the sediment and drive it to the blowoff lines. I then wait about 30 min. and blowoff.

With this procedure, I find more sediment per gallon of blowoff than by any other method I have tried. Of course, this can be done only when conditions are favorable but I firmly believe it is the best method where conditions permit. Mr. Cater's "wash-basin" and "whirl-pool" theory will not be found in any boiler, especially when it is under pressure.

St. Charles, Mo. J. D. DAVY.

Editorial Comment

A New Spirit in Industry

Industrial power plant engineers feel that they should be envied these days for they are getting more fun out of the engineering business than they have had for years. There is real activity in the industrial power plant field now. The factor of obsolescence is of much greater importance than it was 20 yr. ago and the result is a slow but steady awakening of management to the tremendous benefits conferred by a supply of power properly obtained and utilized. In many cases, too, a revamping of the power arrangements of an industrial plant, especially of the power distribution system, to accord with the growth of the industrial processes, yields advantages in convenience, better arrangement of equipment, accuracy of control, improved lighting and other items that produce a general feeling of well-being throughout the plant, a toning up of morale for which it is not always possible to account in dollars and cents.

This condition has been particularly noticeable in industry during the past two or three years. Plants that were running along with old process equipment and methods have often been forced by the advances in the industry to develop new processes and products to meet competition. This has often led to motorizing of equipment, use of unit heaters and of refrigeration and air conditioning for various new processes, new applications of steam, compressed air and the like. In all these problems, the engineer in charge of power supply and distribution plays an important part.

Besides this, many industries have been reaching the point at which the power plant equipment, installed perhaps 20 or 30 yr. ago, has just about reached its normal age limit and something must be done about it. In such a case, the engineer must often analyze the probable future course of the industry to determine whether it should continue to make power or buy it or employ a combination of the two methods. The day has passed when the engineer, finding that the public utility could sell him power cheaper than he could make it, immediately began to worry about his job. If power is bought, he is relieved of only one problem—that of power generation—while all the others remain plus a number of brand new ones.

This is especially true of building and hotel engineers in large cities. These men now have new types of heating systems, new forms of radiation, air conditioning, water pumping for high buildings in which the piping must be laid out on an entirely new basis, electric distribution systems laid out in vertical networks and new forms of high-speed elevators. They are confronted with a host of new and interesting problems that they never had before.

The heat balance diagram of many industries and of some of the larger hotels and buildings is often more complicated than that of many large central stations and may require far more study and care in making up to secure the most economical year-round conditions.

The engineer who knows how to analyze the heat balance not alone of his power plant but of all his industrial applications and services, finds himself well repaid by increased overall economy and more accurate control and a sense of mastery over his problems.

In all these activities, as we have said, we find a new spirit among industrial power plant engineers today. Sometimes a man will get all snarled up and profanely wish for a little peace. But take him out of it for a week and he chafes to get back into the thick of the trouble again. New problems, new equipment, new solutions—and the men who obtain these solutions are the men who are keeping step with every new idea and every new development. Never before has the industrial power field been so interesting to everyone connected with it.

Photo-electric Cell Enters Power Plant

Seeing what takes place around the corner, hearing conversations that go on behind closed doors, tracing concealed movements that occurred days or weeks ago, may be the ambition of the detective but are the accomplishments of the plant engineer. As a matter of fact, only a few of the conditions which the engineer records in his daily report are direct observations of his senses. Feedwater temperatures are not regulated by feeling, pressures are not judged by resistance to muscular strength, furnace conditions are not regulated by color alone, speeds of engines and turbines are not estimated by sound. These things cannot be done without instruments that permit us to look around the corner.

Scientific laboratories are continuously developing methods of determining unknown conditions, a knowledge of which will add to the safety of equipment or increases its efficiency. Probably no other industry uses a greater variety of instruments than does the modern power plant but the list is still growing. In recent years, the development of the science of radio has opened up new principles that are now being utilized not only in control instruments but also for indicating and recording plant conditions. As yet it is impossible to predict how far such devices as the photo-electric cell may be used in power plants but their sensitivity suggests a study of their possibilities wherever controls are found to be sluggish.

Elsewhere in this issue is shown how a photo-electric cell is used to indicate the density of smoke in a stack but the use is being extended to such services as controlling lighting circuits in factories so as to maintain automatically a constant intensity of light throughout work hours. This is a new source of control, the principles of which are likely to enter largely into the design of future power plant instruments and it behooves the engineer to get a thorough understanding of these principles during the initial stages of the development.

Off Duty

In this world of commercial enterprise, we often marvel at the achievements of great organizations such as the General Electric Co., the Westinghouse Electric & Mfg. Co., the American Telephone and Telegraph system and others, and justly so, for these organizations with their all but unlimited resources, have accomplished truly marvelous feats in the world of science and engineering. In the finished products of these companies we find reflected, provided we have some imagination, the mental effort of thousands of individuals over many years.

But achievement is not alone the result of commercial enterprise; in fact, the greatest achievements, the finest accomplishments are often the results of the unselfish, unremitting application of some individual whose only hope of reward lay in the satisfaction he derived from accomplishing his work well. The infinite patience of some inspired individual working alone for the pure joy of it, often produces fruits which commercial enterprise never dreamed of. To such men as John A. Brashear, who, with the most limited of resources, after his day's work, in a shack in the back yard of his modest home, with his own hands fashioned marvelous telescopes with which to study the stars, must be given the credit for the finest things human beings have ever done. This man loved the stars, and this love found expression in the unremitting effort he put into the making of his beloved lenses.

There is something about the work of the non-professional or the amateur, as he is called, that never has been part of commercial enterprise. Whether it be in the field of art or of science, the person who does his work for the pure joy of it, usually excels, for he is imbued with a spirit of accomplishment that amounts to a religion.

The term amateur is often mistaken as a synonym for novice, but this is not so. An amateur as defined by the dictionary is one who cultivates an art or pursues a study from love or attachment and without reference to gain or emolument. Because of this love for his work, the amateur pursues the attainment of his end with a persistence and a patience that the person who works for a day's wages or a month's salary rarely approaches.

Sir Isaac Newton had a job. It was the chair of mathematics at Cambridge in England and he was paid for it. But when it came to astronomy, optics, acoustics and physics generally, where he profoundly advanced scientific knowledge, he did not get a penny because he was a dyed-in-the-wool amateur.

An excellent example of the indomitable spirit of accomplishment that characterizes the activities of the amateur in every field is the amateur in radio. As Hiram Percy Maxim, president of the American Radio Relay League, testified in Washington recently, amateur radio is unique in history. Nothing quite like it has ever before existed. From the earliest days, there has been something about communicating across space that has fascinated those of us who are technically inclined. There is a scientific romance to it that profoundly moves certain of us regardless of the social or financial status to which we happen to have been born.

What the radio amateurs have accomplished is all that radio is today. There is no single development in the radio industry that the amateur has not played a major part. In 1912 when radio really began to be recognized as a vital factor in business, the avarice of commercial enterprise began to make itself felt and so the amateurs were given the waves below 200 meters, which were then considered useless.

Despite the discouragement thus dealt them, the amateurs went at their problem with an enthusiasm which only the most intense love of work could arouse. The commercially judged useless short waves at first did not offer much success but gradually under the constant persuasion of the amateurs, they reached out so that direct contacts could be established all over the country. This led to the casting of wistful glances at the broad Atlantic, and finally, after careful planning, the greatest sporting event in the history of science was "pulled off." With their own hard earned funds, the American amateurs sent one of their number to Europe with American home-made apparatus. His name was Paul F. Godley. After looking the ground over, Godley set up his little station at Ardrossan, Scotland, amid the sceptical remarks of Europeans. When the appointed night and hour arrived, a terrible storm arose and Godley, located in a tent, faced the most discouraging conditions that could be imagined. Cold and wet, but jealously protecting his instruments, he maintained his night long watch and established dozens of contacts with his American brothers. The Englishmen were forced to listen for themselves and generously acknowledged the feat.

This was the beginning of that brilliant series of experiments among the amateurs which startled the whole scientific world. It began to be suspected that 100 meter waves might be controlled and such proved to be the case; they were marvelously better than 200 meters. It did not take long to find that 80 meter waves could be controlled and then 40 meters. And then unbelievable records in long distance communication were hung up. When 20 meters was reached and amateurs at the Antipodes were brought within reach, the amateur radio telegrapher with his home made apparatus bridged the ultimate terrestrial distance. With home-made apparatus costing but a few dollars and with an amount of power less than that taken by an ordinary 60-watt lamp, the amateur circled the globe, a feat which commercial stations with equipment costing hundreds of thousands of dollars and hundreds of kilowatts could do only with difficulty.

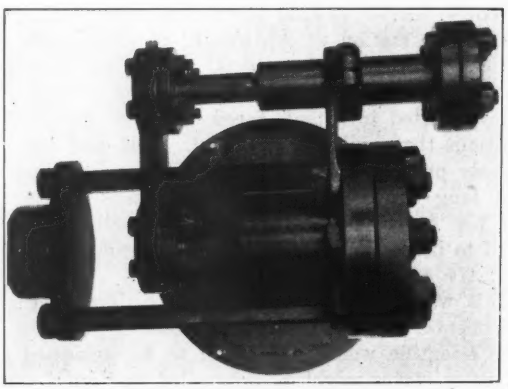
This story of amateur radio is without question the most romantic and fascinating in the entire history of science, for behind it lies an inherent love for accomplishment that probably never has been equaled. Those readers of this magazine who are interested in it are referred to the April number of QST, in which Mr. Maxim's testimony before the Senate Committee on Interstate Commerce appears. It is a document unique in its heartfelt appeal for individual expression and in its freedom from avarice.

This is not a criticism of commercial enterprise, for in a world where the rule of existence is that of the survival of the fittest, commercial enterprise has no alternatives. It is rather an appeal for the encouragement of those workers in any field whose love and interest in their work is such that they will suffer privation and want and exhibit the most unbelievable patience in the accomplishment of their end.

Power Plant Engineering Developments and News

High-Pressure Flow Meter

INCREASING USE of high pressures for boilers and for process work has led to the development of a new Foxboro flow meter guaranteed to stand a working pressure of 0 to 5000 lb. per sq. in. It has been built



REAR VIEW OF NEW 5000-LB. METER SHOWING PRESSURE PARTS MADE OF DROP FORGINGS

for measuring the flow of gas, air, steam, hot oil and gasoline.

While retaining all the features of Foxboro orifice meters, the pressure chambers of this new meter have been constructed to meet the higher pressures with absolute safety. All working parts subjected to pressure are drop forgings, specially designed for high pressure work.

The new meter is calibrated to read and record in terms of flow and may be equipped with an integrator that reads direct without multipliers the total flow in gallons or feet or pounds.

This new meter is made by The Foxboro Co., Foxboro, Mass.

Flexible Coupling

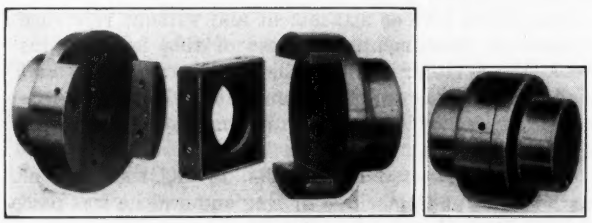
NEW DESIGN of shaft coupling, known as the American flexible coupling, is being marketed by the American Flexible Coupling Co., Erie, Pa. This device, it is stated, is a variation of the Oldham coupling, in which a center member is constrained to slide across the face of one coupling flange on a line passing through the center end, at the same time, is free to slide across the face of the second flange in a direction at right angles to the first.

The floating center member of the American flexible coupling is a square, hollow casting, with a hole in the center to provide clearance for the shaft ends. To the edges of this floating member are fastened replaceable bearing strips made from a hard, tough, nonmetallic compound, such as is used in the manufacture of nonmetallic pinions and gears.

Flange sections are identical and interchangeable, except for the bore diameters, which are made to suit the shafts. The flange is cast in one piece with a hub of ample dimensions. A wide groove is machined in the face of the flange, leaving two jaws between which the floating member slides and by which the torque is transmitted.

The coupling is designed to be removed without the use of special tools by simply pulling the jaw flanges apart horizontally or sliding them past each other vertically. The nonmetallic bearing strips can be replaced in a few minutes, it is stated, without disturbing the coupling or the connected shafts. The bearing strip screws are removed through holes in the jaws, when the old strips can be slipped out and new ones inserted.

The floating hollow center member is filled with grease which passes to the surfaces of the wearing strips through suitable channels furnished with wicks. In operation, centrifugal force assists proper lubrication, it is claimed. By means of an ordinary grease gun, the center member can be filled with fresh grease through any one of the bearing strip screw holes. It is stated by



LEFT—CONSTRUCTION OF NEW AMERICAN FLEXIBLE COUPLING. RIGHT—COUPLING ASSEMBLED

the manufacturer that the coupling provides maximum flexibility without the use of flexible materials; that the device does not deteriorate rapidly when subjected to moisture, heat and dirt; that it is convenient and accessible for replacement or repairs with a resulting low cost for maintenance and lost production time.

Wide-Radius, Broad-Gage, Heavy-Duty Derrick Crane

FULL-CIRCLE, long-boom, broad-gage, crane and dragline is being offered by the American Hoist & Derrick Co. of St. Paul, Minnesota, for use in the general construction, excavating, and sand and gravel indus-

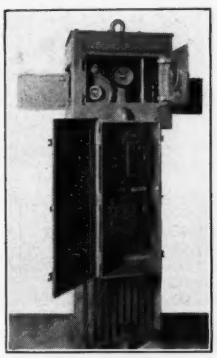
tries. This machine will be known as the American Revolver.

Its main features are stated to be: ability to handle heavy working and lifted loads at wide working radius; ease of movement by wheel mounting on track, or skid and rollers over rough ground; simplicity of its all steel construction; stability, and ready adaptation to all classes of heavy crane, derrick, or dragline work. Steam, Electric, Diesel or Gasoline power can be furnished. Mounting can be arranged to suit requirements.

The American Revolver is available in three sizes with booms 75, 85 or 100 ft. long and turntable diameters of either 14 or 20 ft.

New Line of Westinghouse Voltage Regulators

POPULARITY OF the new Westinghouse outdoor feeder voltage regulator with the vertical bushings has led to the adoption of the same design for the entire line of Westinghouse outdoor regulators. The weather-



WESTINGHOUSE REGULATOR WITH DOORS OPEN

proof hood, the vertical bushings, the mounting of the transformers which are connected before the regulator leaves the factory, the accessibility of accessories, the swinging panel, the centralized lubrication system and the position indicator are distinctive features of the new design.

Fourth Unit for Mistersky Power Station, Formerly Morrell St.

PUBLIC LIGHTING COMMISSION of the City of Detroit is adding a fourth unit to its Mistersky Power Station. The name of this station was formerly Morrell Street but has recently been changed to Mistersky Power Station, in memory of the late Superintendent of Public Lighting who died January 6, 1930, after 30 yr. of service to the city, as noted in the March 15, 1930 issue of Power Plant Engineering.

It is expected that the fourth turbine unit will be placed in service on April 15, using the existing boiler capacity. The two new boilers which are being installed as part of the fourth unit will be ready to place in service by July 30, 1930. Smith, Hinchman & Grylls, Detroit, Mich., are designing engineers for the entire project.

The fourth unit equipment is made up of the following, the design and capacities being approximately the same as the present three units:

TURBINE GENERATORS	Westinghouse Electric & Mfg. Co.
Capacity	20,000 kw., 8 p.f.
Steam pressure, throttle	385 lb. gage
Steam temperature, throttle	730 deg. F.
Steam pressure, exhaust	1 in. Hg. abs.
Speed	1800 r.p.m.
CONDENSER	Elliott Co.
Type	Horizontal, surface, two-pass, non-divided water box
Surface, sq. ft.	26,000
CONDENSER CIRCULATING PUMPS	Lecourtenay Co.
Number	2
Type	Single stage, centrifugal
Capacity, each	12,750 g.p.m., 14.57 ft. head
Drive	75 hp., var. speed, d.c. motor
CONDENSATE PUMPS	Lecourtenay Co.
Number	2
Type	3 stage, centrifugal
Capacity, each	600 g.p.m., 380 ft. head
Drive	100 hp., 1750 r.p.m. a.c. motor
AIR EJECTOR	Elliott Co.
Number	2
Type	2 stage, steam jet
Capacity	19 c.f.m. at 1.5 in. abs.
BOILERS	Combustion Engineering Corp.
Number	2
Type	Sectional cross drum
Heating surface, sq. ft.	9810
Steam pressure, lb. abs.	400
Steam temperature, deg. F.	730
Steam capacity, lb. per hr	200,000
SUPERHEATERS	Foster Wheeler Corp.
Type	Convection, radiant
Surface, sq. ft., convection	3420
Surface exposed, sq. ft., radiant	219
FURNACES	Combustion Engineering Corp.
Number	2
Type	Lopulco
ECONOMIZERS	Combustion Engineering Corp.
Number	2
Type	fin tube counter flow
Surface, sq. ft.	5420
AIR PREHEATERS	Combustion Engineering Corp.
Number	2
Type	Vertical plate, counter flow
Surface, sq. ft.	11,070
INDUCED DRAFT FANS	B. F. Sturtevant Co.
Number	2
Type	Turbovane
Size	372,000 lb., 10.5 in. w.g. and 400 deg. F.
Drive	var. speed, a.c. motor, 400/150 hp.
FORCED DRAFT FANS	B. F. Sturtevant Co.
Number	2
Type	Turbovane
Size	60,000 c.f.m. at 7.5 in. w.g. and 75 deg. F.
Drive	var. speed a.c. motor, 125/50 hp.
BOILER FEED PUMP	DeLaval Steam Turbine Co.
Drive	300-hp. d.c. motor
Capacity	625 g.p.m.
Speed	1200 r.p.m.
Stages	10
MAIN TRANSFORMERS	General Electric Co.
Number	1
Type	Auto
Size	25,000 kv-a.
Voltage	13,200/24,000

Production of Electricity and Consumption of Fuels

PRELIMINARY FIGURES of the total production of electricity by public-utility power plants in the United States in 1929 indicate an output of 97,294,000,000 kw-hr., an increase of nearly 11 per cent over the output in 1928.

Low precipitation throughout the country during 1929 resulted in low water in most of the streams used

TABLE I. PRODUCTION OF ELECTRICITY AND CONSUMPTION OF FUEL BY PUBLIC-UTILITY POWER PLANTS IN THE UNITED STATES, 1929

1929

	Output (Thousands of kilowatt-hours)				Fuel consumption		
	Total	Water power	Fuel power	By use of wood a/	Coal (net tons)	Oil (barrels)	Natural gas (M cubic feet)
United States	97,293,683	34,609,666	62,684,017	364,786	44,925,222	10,079,129	112,847,040
New England	6,628,400	2,022,639	4,605,761	100	3,157,126	1,665,606	0
Middle Atlantic	24,711,130	6,450,706	18,320,424	0	14,076,925	326,554	91,304
East North Central	23,264,949	2,510,344	20,754,605	7,418	16,957,647	79,868	4,070,810
West North Central	5,674,085	1,588,460	4,085,625	10,406	4,033,264	937,491	11,778,193
South Atlantic	11,900,201	6,561,849	5,338,352	2,217	3,822,395	2,262,360	153,302
East South Central	3,634,222	2,811,316	822,906	4,610	807,930	96,782	3,425,189
West South Central	4,897,465	72,490	4,824,975	401	1,231,561	891,988	65,584,772
Mountain	3,967,326	3,282,408	684,918	15,737	681,602	420,347	829,143
Pacific	12,555,905	9,309,454	3,246,451	323,897	96,772	3,398,133	26,914,327

for water power, and in consequence the production of electricity at hydroelectric plants was about 1½ per cent less than in 1928. The water-power output during the previous seven years had shown increases ranging from 3 to 17 per cent and averaging 13 per cent. As a result of the decrease in 1929, fuel-burning power plants were forced not only to supply the usual yearly increase in the demand for electricity but also to make up the deficiency in output at water-power plants. That the fuel-burning plants were able without trouble to take care of this increased and unexpected demand for electricity speaks well for the judgment and foresight of those responsible for providing adequate equipment at public-utility power plants for emergency use as well as for future growth.

The annual increase in output of electricity by the use of fuels for 1927 and 1928 was about 5½ per cent. In 1929 the increase was 18 per cent or about three times the increase for each of the preceding two years. The increases in consumption of coal, oil, and gas over 1928 were 9, 41, and 46 per cent respectively. Although the unusual increase in the output of electricity by fuel-burning plants might have been expected to reduce their efficiency in the use of fuel, they continued the improvement in efficiency which has been shown for many years, reducing the average rate of fuel consumption from the equivalent of 1.76 lb. of coal per kilowatt-hour in 1928 to 1.69 lb. in 1929. This saving of 0.07 pound or 1⅛ oz. of coal per kilowatt-hour amounted to 2,200,000 t. of coal during 1929 and represents a total saving of about $9,000,000. The increase of efficiency thus indicated is most forcibly shown by noting that the increase in output of electricity by the use of fuels from 1928 to 1929 was 18 per cent, while the consumption of fuels increased only 13 per cent.

TABLE II. ANNUAL PRODUCTION OF ELECTRICITY BY PUBLIC-UTILITY POWER PLANTS IN UNITED STATES, 1919-1929

Year	Total		Water power			Fuel power		
	Kilowatt-hours	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)
1919	30,921,000,000	----	14,606,000,000	37.5	----	24,315,000,000	62.5	----
1920	43,555,000,000	+ 11.9	16,150,000,000	37.1	+ 10.6	27,405,000,000	62.9	+ 12.7
1921	40,975,000,000	- 5.9	14,970,000,000	36.5	- 7.3	26,005,000,000	63.5	- 5.1
1922	47,654,000,000	+ 16.3	17,207,000,000	36.1	+ 14.9	30,447,000,000	63.9	+ 17.1
1923	55,665,000,000	+ 16.8	19,343,000,000	34.8	+ 12.4	36,322,000,000	65.2	+ 19.3
1924	59,014,000,000	+ 6.0	19,969,000,000	33.8	+ 3.2	39,044,000,000	66.2	+ 7.5
1925	65,870,000,000	+ 11.6	22,356,000,000	33.9	+ 11.9	43,514,000,000	66.1	+ 11.4
1926	73,791,000,000	+ 12.0	26,189,000,000	35.5	+ 17.1	47,602,000,000	64.5	+ 9.4
1927	80,205,000,000	+ 8.7	29,875,000,000	37.2	+ 14.1	50,330,000,000	62.8	+ 5.7
1928	87,851,000,000	+ 9.5	34,747,000,000	39.6	+ 16.3	53,104,000,000	60.4	+ 5.5
1929	97,254,000,000	+ 10.7	34,610,000,000	35.6	- 1.4	62,684,000,000	64.4	+ 18.0

The information in the accompanying tables is based on the figures of production of electricity previously published in the regular monthly power reports issued in mimeographed form by the Geological Survey, Department of the Interior. The output of central stations, both commercial and municipal, and electric railway plants is included in these monthly reports.

Copies of this report may be obtained by application to the Director, Geological Survey, Washington, D. C.

TABLE III. AVERAGE CONSUMPTION OF COAL PER KILOWATT-HOUR BY PUBLIC-UTILITY POWER PLANTS IN UNITED STATES, 1919-1929

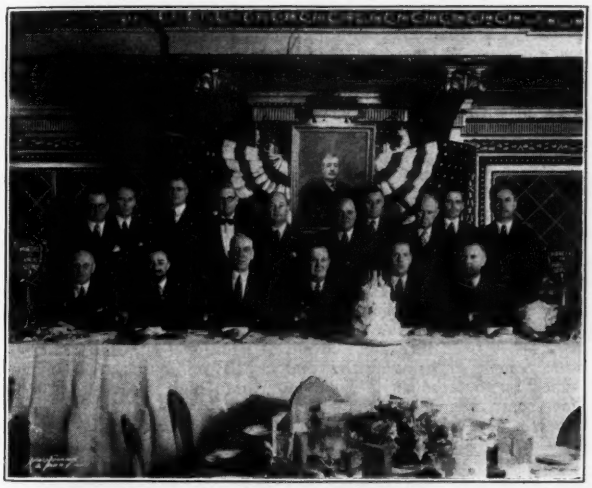
Year	Output by the use of fuel (coal, oil, and gas)		Consumption of coal and coal equivalent of oil and gas.			
			Total		Per kilowatt-hour	
	Kilowatt-hours	Change from previous year (per cent)	Net tons	Change from previous year (per cent)	Pounds	Per cent of rate in 1919
1919	24,175,000,000	----	38,880,000	----	3.2	100
1920	27,248,000,000	+ 12.7	41,420,000	+ 6.5	3.0	94
1921	25,863,000,000	- 5.1	35,240,000	- 14.9	2.7	84
1922	30,234,000,000	+ 16.9	38,000,000	+ 7.8	2.5	78
1923	36,088,000,000	+ 19.4	43,522,000	+ 14.5	2.4	75
1924	38,808,000,000	+ 7.5	43,130,000	- .9	2.2	69
1925	43,264,000,000	+ 11.5	44,780,000	+ 3.8	2.1	66
1926	47,274,000,000	+ 9.3	45,856,000	+ 2.4	1.95	61
1927	49,995,000,000	+ 5.8	45,910,000	+ .1	1.84	57
1928	52,733,000,000	+ 5.5	46,434,000	+ 1.1	1.76	55
1929	62,319,000,000	+ 18.2	52,582,000	+ 13.2	1.69	53

Copies of this report may be obtained by application to the Director, Geological Survey, Washington, D. C.

Fifth Annual Byllesby Engineering Convention

WITH A TOTAL REGISTRATION of 279, the Fifth Annual Convention of the Byllesby Eng. & Mgt. Corp. was held at the Congress Hotel in Chicago on March 24, 25 and 26, under the direction of H. W. Fuller, vice-president in charge of engineering and construction. At the banquet held the evening of March 26, Johnson O'Connor, manager of the Department of Human Engineering of the General Electric Co., gave the principal address, discussing the measurement of executive ability.

All sections of the country served by units of the Standard Gas & Electric System were represented. As



THE SPEAKERS' TABLE AT THE BYLLESBY BANQUET

Seated, left to right: General Charles Keller, B. E. & M. Corp.; Johnson O'Connor, General Elec. Co.; H. W. Fuller, v. p. in charge eng. & const., B. E. & M. Corp.; A. C. Allyn, pres., A. A. Allyn & Co.; H. C. Cummins, asst. to v. p. in charge of operation, B. E. & M. Corp.; F. H. Lane, mgr. eng. & const., B. E. & M. Co. Standing, left to right: P. O. Crawford, pres., Federal Pub. Serv. Co.; H. W. Eales, chief elec. eng., B. E. & M. Corp.; W. D. Batchelder, General Elec. Co.; John L. Gray, v. p. & gen. mgr., Shaffer Oil & Ref. Co.; O. G. Corns, v. p., H. M. Byllesby & Co.; E. Uhlendorf, mgr. valuation dept., B. E. & M. Corp.; A. C. Bull, purchasing engineer, B. E. & M. Corp.; Judge R. M. Campbell, Cummins, Roemer & Flynn; Major H. S. Bennion, director of eng., N. E. L. A.; C. W. Farrier, asst. director of works, Chicago World's Fair.

a part of the Comprehensive program covering construction and engineering features of the various projects, many papers were presented. Prize awards for outstanding papers were announced at the banquet as follows: excellent subject matter presented in an entertaining way, A. H. Hamilton, Northern States Power Co.; excellent subject matter and suggestions acted upon during the convention, J. D. McPherson, California-Oregon Power Co.; excellent solution of an engineering problem, L. D. Gilbert, Byllesby Eng. & Mgt. Corp.

Mr. Hamilton's paper dealt with the construction of the Granite Falls (Minnesota) Station, which is now under construction, and was illustrated by slides and moving pictures; Mr. McPherson's paper considered the proper accounting methods of taking care of certain charges during construction and Mr. Gilbert's paper discussed development details of the hogged fuel furnaces at the Coos Bay Station.

News Notes

ELECTRIC MACHINERY MFG. Co., Minneapolis, Minn., announces that its Baltimore office, formerly at 432 North Calvert St., will now be located at 600 North Calvert St.

DIAMOND POWER SPECIALTY CORP. announces the removal of its Chicago offices to suite 1540-42, 20 North Wacker Drive, Chicago, Ill.

ROLLER-SMITH CO., 233 Broadway, New York, N. Y., announces the appointment of Henry N. Muller Co., First National Bank Building, Pittsburgh, Pa., as its district sales agent in Western Pennsylvania, Eastern Ohio and West Virginia.

LEEDS & NORTHRUP CO., 4901 Stenton Ave., Philadelphia, Pa., announces new address of its Cleveland office at 1941 Union Trust Building, Cleveland, Ohio. The former location was 1228 Union Trust Building.

C. BRIGHAM ALLEN, JR., has been appointed district sales representative of the Philadelphia office of the Reliance Electric & Engineering Co., Cleveland, Ohio.

KIELEY & MUELLER, Inc., New York City, is now represented in Indianapolis by George Heidenreich, Board of Trade Bldg., Indianapolis, Ind., and in Detroit by the Woolley Engineering Co., 251 West Jefferson Ave., Detroit, Mich.

THE STEPHAN CO., 7016 Euclid Ave., Cleveland, Ohio, announces that it has been appointed a representative of Strong-Scott Manufacturing Co., Minneapolis, Minn.

THE BIGELOW CO., New Haven, Conn., has elected Gustav Welter and Paul M. Fleming assistant vice presidents and Herbert W. Horton assistant secretary and purchasing agent. W. R. Holmes has been appointed Sales Engineer in the New York office, succeeding Thomas C. Vincent, Jr., resigned.

W. H. BARTHOLD, New York, was elected president of the Illinois Power Co. at the directors' annual meeting in Springfield, succeeding B. C. Cobb, also of New York. Other officers were reëlected as follows: A. D. Mackie, vice president and general manager; E. W. Payne, second vice president; James A. Easley, third vice president; W. H. Lemons, secretary; and E. L. Sturtevant, treasurer. These officers and George W. Bunn, H. A. Converse, Addison Corneau, W. B. Jess, R. C. Lanphie and W. F. Workman were named directors at the stockholders' meeting which preceded the board organization.

ORGANIZATION of the Nebraska Public Service Co., which will handle electric gas and natural gas business and affiliated activities in Nebraska as subsidiary of the Sioux City Gas and Electric Co., was announced recently. W. J. Bertke, president of the parent concern, heads the Nebraska corporation with Heber Herd, organizer of the old Hartington Electric Co., now merged with the Interstate Power Co., as vice president. The new corporation will expand through the northern Nebraska territory as result of contracts with the Interstate Power company which will secure power from the Big Sioux power plant at Sioux City for the greater part of the northern Nebraska territory.

MORLEY S. SLOMAN, who has been associated with the Pittsburgh office of Sullivan Machinery Co., has been appointed manager at the Huntington branch to succeed John S. Walker, Jr., who retired from the company to engage in banking in Huntington.

R. E. HELLMUND, chief electrical engineer of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., has just been elected a member of the board of directors of the German Institute of Electrical Engineers.

SILICON CARBIDE is the basis for a group of abrasive and refractory materials largely used in mechanical and electrical construction and processes. "Carborundum" is not a generic term for this group, but is a trade-mark name given by the Carborundum Co. to its products, registered as applying only to those products. Use of that name in a generic sense is, therefore, misleading as well as improper as the name "Carborundum" signifies only to the special products of the company. Silicon carbide is the generic name which should be used for all other materials or products of this class.

CHICAGO PNEUMATIC TOOL CO., 6 East 44th St., New York City, announces the opening of new branch offices as follows: Oklahoma City, Okla., Perrine Building; Tulsa, Okla., 327 Philcade Building; Houston, Texas, Merchants & Manufacturers Bldg.

MARCH MEETING of Anthracite Lehigh Valley Section, A. S. M. E. was held in the Wyomissing Club Ball Room on Friday evening, March 21. F. H. Dechant, manager of the Reading District, presented a program somewhat representative of the professional activities in and around Reading, immediately following an excellent dinner. E. A. Borell drew comparisons of the present day locomotive engine and the earlier type and gave a good description of the new continuous automatic train control equipment. Hugo Hemmerick, of Textile Machine Works gave a brief but

graphic history of the development of the modern Textile industry, and its adoption and use of machinery. E. M. Gilbert, of the Associated Gas & Electric System, told of the rapid growth of the public utility, the increase of operating efficiencies obtained through engineering study and research and the economies of capital realized through system interconnections. Relation of tools to the engineering profession was pointed out by George V. Luerssen of the Carpenter Steel Co. The closing address was The Story of Wrought Iron, illustrated with moving pictures by R. W. Thompson of Reading Iron Co.

Acccording to a recent announcement, 1929 was the best in the history of the General Electric Co. in volume of orders received, shipments billed, total profits and earnings per share of common stock.

Orders received during 1929 increased 28 per cent over 1928, sales billed increased 23 per cent, net income from sales increased 24.5 per cent, and earnings per share of common stock increased 25 per cent, the annual report, released by Gerard Swope, president, disclosed.

Profit available for dividends amounted to $67,289,880, equivalent, after dividends on the special stock, to $8.97 a share on the 7,211,481 shares of no par value common stock, compared with $54,153,806 or $7.15 a share for 1928.

Orders received during 1929 amounted to $445,802,519, compared with $348,848,512 in 1928, an increase of 28 per cent, and unfilled orders at the end of the year totalled $94,623,000, compared with $72,953,000 at the close of 1928. an increase of 30 per cent. Sales billed for 1929 were $415,338,094, compared with $337,189,422 in 1928, an increase of 23 per cent.

Net income from sales in 1929 amounted to $49,395,896, which, compared with $39,661,230 in 1928, shows an increase of 24.5 per cent.

John G. Farrar, chief traveling auditor of the General Electric Co., has been appointed assistant general auditor to succeed F. H. Corregan, who resigned to become secretary and treasurer of the RCA Radiotron Co., Inc., it has beeen announced by S. L. Whitestone, comptroller.

Sandvik Conveyor Mfg. Co., Newark, N. J., has opened an office at 180 No. Michigan Ave., Chicago, Ill., in charge of Morton Fries.

Tube Turns, Inc., of Louisville, Ky., announces the appointment of The E. F. Keating Co., 452 Water St., New York City; Himelblau-Agazim & Co., 30 North Dearborn St., Chicago, Ill.; and Stewart Machinery Co., Buder Building, St. Louis, Mo., as distributors. W. P. Curley and A. L. Breyvogel will continue as managers of the New York and Chicago branch offices respectively.

George Montefiore Prize for 1929 has been awarded to R. D. Evans and C. F. Wagner, Westinghouse engineers, in conjunction with three other engineers, Algeri Marino of Rome and H. Parodi and Pestarine of Paris. This triennial prize presented by the Foundation George Montefiore of Liege, Belgium, for the best original work contributing to scientific advancement in the technical applications of electricity was given to Messrs. Evans and Wagner for their papers on 'Studies of Transmission Stability' and 'Static Stability Limits and the Intermediate Condenser Station.' The amount awarded to Messrs. Evans and Wagner was 3,000 Belgian francs.

As shown by its annual report, made public March 12, the sales billed, the orders booked and the net income of the Westinghouse Electric & Manufacturing Co. for the year ending December 31, 1929, exceeded those for any previous year in the company's history.

The income account for 1929 compares as follows with that for 1928, which was also a record year:

Gross earnings—	*1929*	*1928*
Sales Billed	$216,364,588	$189,050,302
Cost of sales	194,371,987	170,867,970
Net manufacturing profit	21,992,601	18,182,332
Other income	5,323,743	4,146,991
Gross income from all sources	27,316,344	22,329,323
Interest charges, etc.	253,733	1,514,383
Net income available for dividends and other purposes	27,062,611	20,814,940

The volume of unfilled orders on January 1, 1930, was $62,025,399, a gain of approximately $15,000,000 over last year. The total of current assets is more than six times the total of current liabilities which represent the entire indebtedness of the company. The surplus shows an increase during the year of $29,729,690. The operating income for the year was $27,062,611 and deducting the dividends paid or declared aggregating $11,327,668, the increase in surplus from operations was $15,734,943. The balance, $13,994,747, of the total increase in surplus represents the net gain from the sale during the year of additional common capital stock at a premium, the proceeds from which sale were used to redeem the outstanding issue of $30,000,000 bonds which were called for redemption on March 1, 1929. The company now has no capital liability of any nature other than its capital stock. The number of stockholders rose to 44,088, an increase of over 9,000 during the year.

Hahn Engineering Co. has ceased to be a division of the Lancaster Iron Works, Inc., in Lancaster, Pa., and has become a division of the Treadwell Engineering Co., with main offices and works in Easton, Pa. The New York office is located at 90 West St.

Sarco Co. Inc., 183 Madison Ave., New York, announces the appointment of Gus. A. Binz as manager of sales promotion, which includes charge of advertising. Mr. Binz was for 8 yr. manager of sales and advertising for American Schaeffer & Budenberg Corp., and previously sales manager of Yarnall-Waring Co.

John L. Gray, vice president and general manager, announces that the name of Shaffer Oil and Refining Co., 300 West Adams St., Chicago, Ill., will be changed to Deep Rock Oil Corp., effective April 1, 1930. The corporation will continue as a unit of the Standard Gas and Electric Co. system. Subsidiaries of Shaffer Oil and Refining Co., which include the Home Oil Co. (operating in Minnesota, North Dakota and South Dakota), the High Test Oil Corp. in Oklahoma and Arkansas, and the Deep Rock Oil Co. of Wisconsin and Michigan have been operated under their individual names as marketing and distributing units of the Shaffer Co. Effective with the change in name of Shaffer Oil and Refining Co., however, the corporate status and names of these companies also will be changed inasmuch as they are a part of the Deep Rock Oil Corp. Approval of the change in name was made at a meeting of stockholders of Shaffer Oil and Refining Co., March 20, at which meeting all directors of the company were reëlected.

Central Illinois Public Service Co. was serving 433 communities at the end of 1929, according to annual report submitted at the stockholders' meeting in the company offices, 217 North Ninth St., Springfield, Ill. Samuel Insull, Martin J. Insull, Marshall E. Sampsell, president, and J. Paul Clayton, vice president, were reëlected to the board of directors. Edward F. Kelly, executive manager, James L. Gray, auditor, and Samuel Insull, Jr., were chosen as new members of the board at the business meeting. Gross earnings for the year were $15,218,443.80, an increase of $872,444.49 over 1928 and 220 mi. of additional transmission lines were completed, bringing the total to 3103 mi. operated and maintained by the company. Completion of a high capacity 33,000-v. line from Greenview to the East Springfield sub-station, providing a new source of supply from the Powertown station of the Super-Power Co. of Illinois and interconnections of the 33,000-v. line as well as a score of new transmission lines were completed during the period. The company reported 21,243 stockholders, a gain of 1687 over 1928, with 94 per cent of its employes now listed as stockholders.

Harvard Award for the "general or institutional advertising campaign conspicuous for the excellence of its planning and execution," established by Edward W. Bok, late philanthropist and publicist of Philadelphia, has been presented to the Westinghouse Electric and Manufacturing Co. This award was the first given to a national institutional advertising campaign in newspapers since the founding of the event. The award, consisting of a certificate and a cash prize of $2000, was made by Dean Wallace B. Donham of the Harvard Graduate School of Business Administration to J. C. McQuiston, general advertising manager of the Westinghouse Company and to A. L. Billingsley, president of Fuller & Smith, Cleveland, advertising agency of Westinghouse.

C. H. Jensen has joined the engineering staff of the Copperweld Steel Co., Glassport, Penna. He was formerly with the Pittsburgh Branch of the Byllesby Engineering and Management Corp.

Peabody Engineering Corp., whose offices for the past 8 yr. have been in the Bowery Savings Bank Building at 110 East 42nd St., New York City, will move to new quarters, which it has leased for 10 yr., on or about April 15, 1930, occupying the entire 39th floor of the Lefcourt Colonial Building on the southeast corner of 41st St. and Madison Ave.

King & Shepherd, 50 Church St., New York City, has been appointed distributor, for the Manhattan district, by the Mason Regulator Co., Dorchester Center, Boston, Mass.

Harry E. Dunham, patent attorney with the General Electric Co. since 1912, has been appointed assistant manager of the Patent Department, according to an announcement made by Charles E. Tullar, manager of the department.

On April 1 Reed, Midwest and National Air Filter Companies were consolidated and hereafter will function as one organization under the name of the American Air Filter Co., Inc., the latter being formerly holding company for the three concerns.

Whitney Corp., Harvey, Ill., announces the appointment of E. F. Lindsay as sales manager of its Harrington Division.

Catalog Notes

SK STEAM JET HEATERS for liquid are described in bulletin No. 3-A by Schutte & Koerting Co., Philadelphia, Pa. This is a completely revised edition of its former bulletin on the subject. The bulletin contains tables of sizes and capacities with charts, diagrams of water flow in colors and many illustrations showing how the steam jet heaters can be applied to heat water for washing and other industrial purposes, as well as other liquids used in industry.

PURIFICATION OF STEAM for the protection of superheaters, turbines and similar equipment against moisture and solids is treated in detail in bulletin No. 684 recently published by The Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia, Pa. Benefits of clean steam are discussed, causes of dirty steam, requirements to be met by steam purifiers. Details of the Cochrane purifier, designed for installation between the steam drum and the superheater are shown with illustrations and discussion of application. Tables of capacities and dimensions are also given.

INDUCTION VOLTAGE REGULATORS for single-phase operation are described in bulletin GEA-1155A by General Electric Co., Schenectady, N. Y. The bulletin describes and illustrates details of this equipment and shows how it is applied.

Automatic Network Protectors for alternating-current systems, 250 v., 60 cycles, 15,000 amp. at 250 v., are described in bulletin GEA-744A.

Type CL-2 Control and Instrument Switches for electrically-operated governors and rheostats and instrument transfer are described in bulletin GEA-1045A.

Truck-Type Switching Equipment, manual, motor, solenoid or automatic reclosing operation for 220 to 15,000 v., 25 to 60 cycles, are described in bulletin GEA-474A.

Type CN-1 Air Circuit Breakers and Types CK-1 and CK-2 Air Circuit Breakers are described in other bulletins, while bulletin GEA-19F describes A-C Enclosed Switches for alternating-current motors.

Single-Stage Centrifugal Air Compressors for Cupola Blowing are described in bulletin GEA-904C.

GE Quiet—operating Induction Motors are discussed and illustrated in detail in bulletin GEA-1231.

ELECTRIC EQUIPMENT for Handling Heavy Material is treated in bulletin GEA-1232, a 24-page, well-illustrated bulletin, showing cranes, ore bridges, hoists, coal towers and other equipment for which motors and control equipment is supplied.

In bulletin GES-402A, the company gives a list of motion pictures and illustrated lectures that may be borrowed from the General Electric Co. Many of these are films with synchronized sound.

IN BULLETIN No. 251, Builders Iron Foundry, Providence, R. I., describes briefly its complete line of meters for power plant use, including the Venturi meter, the Oriflo meter, Type KS shunt meter and the diaphragm meter, together with Selsyn operated devices for use with the Venturi meter.

ECONOMY OF SOFT WATER is the title of a 16-page bulletin just issued by the Elgin Softener Corp., Elgin, Ill., describing the Elgin zeolite water softening system. It discusses the advantages of soft water in various industries, problems involved in obtaining it, characteristics of boiler feedwater and so on. Description is given of the Elgin zeolite deconcentrator combination, the continuous blowdown system with heat exchanger and the Elgin deconcentrator. Diagrams and photographs illustrate the discussion. This bulletin, No. 120, may be obtained upon request to the above company.

STANDARDIZED FEEDWATER TREATMENT with centralized control discusses the general characteristics of KWS sodium aluminate made by National Aluminate Corp., 6216 West 66th Place., Chicago, Ill., and described the advantages of using it in feedwater treatment.

RILEY-LAMONT WATER WALLS are completely described, with a detailed discussion of their operation and drawings of installations in a 16-page, well-illustrated bulletin recently issued by Riley Stoker Corp., Worcester, Mass.

METTALLO GASKETS are described in catalog No. 30, issued by the Metallo Gasket Co., 10 to 18 Bethany St., New Brunswick, N. J. The bulletin describes plain corrugated metal gaskets, corrugated metal-asbestos cord inlaid gaskets and other types and gives tables of sizes and prices of the various kinds available.

THE G-R EQUAFLO HEAT EXCHANGER, as described in the March 1 issue of Power Plant Engineering, is discussed in Form 465, by The Griscom-Russell Co., 285 Madison Ave., New York City.

LINK-BELT ROLLER CHAIN DRIVES are completely described in Data Book No. 1257, a 96-page illustrated book bound in flexible cover, just issued by Link-Belt Co., 910 So. Michigan Ave., Chicago, Ill. The book describes the Link-Belt roller chain in detail with many illustrations showing the action of the Link-Belt curve roller, gives tables of dimensions and stock sizes, notes on design, tables of horsepower and sprocket wheels and many photographs of actual installation.

POWER DRIVE EQUIPMENT consisting of couplings, clutches, watercooled and heavy-duty oil film bearings, floor stands, hangers and similar equipment, is described in a loose-leaf illustrated bulletin issued by the Hill Clutch Machine & Foundry Co., 6400 Breakwater Ave., Cleveland, Ohio.

RIC-WIL SEWER and drain products are described in bulletin D sent out by the Ric-Wil Co., Cleveland, Ohio. This describes the Ric-Wil cradle base drain, Ric-Wil sewer joint compound, equipment for applying it, cast-iron drain pipe, filter tape and similar equipment.

WHITING TIGER CRANES, described in bulletin 188 just issued by Whiting Corp., Harvey, Ill., are discussed in detail with many illustrations. Construction of the gears, complete trolley assembly, various bridge drives and electrical control equipment and tables of dimensions for laying out are given at the end. In another 4-page bulletin, the company describes the Whiting stoker, formerly the King Coal stoker, made by the Harrington Division of the corporation.

CONDENSED AND TABULATED HEATING RATES for heating season of 1929 and 30 are being issued in bulletin form by the Ric-Wil Co., Union Trust Bldg., Cleveland, Ohio.

WESTINGHOUSE ELECTRIC & MFG. CO. recently published Leaflet 20,451 describing the new FO-22 Weatherproof Oil Circuit-Breaker, which is rated at 400, 600, and 800 amp., 7500 v.

This publication describes in some detail the construction of this breaker, and this description is supplemented by photographs of the apparatus. The breaker is made for manual, d.c. solenoid and a.c. rectox operation, and the leaflet describes these various operating mechanisms. The breaker with its moisture and dust-proof features is suitable for outdoor installation or for indoor service where there is a great deal of dust or moisture.

PUMP-FAX is the title of an interesting handbook on pumping issued by Goulds Pumps, Inc., of Seneca Falls, N. Y. It deals with characteristics of reciprocating, centrifugal and rotary pumps, comparison of types, figuring of head, discharge and power, as well as installation and operation. Of the 65 pages, 34 are text matter, 15 tables and curves of hydraulic data and pump performance.

NUGENT HIGH-PRESSURE automatic bypass oil filter for fuel and lubricating oils, is completely described and its parts are illustrated in a recent bulletin by Wm. W. Nugent & Co., Inc., 410 No. Hermitage Ave., Chicago, Ill. Various parts of the system are shown in detail, diagrams show how it is connected and illustrations show the method of cleaning.

SYNCHRONOUS MOTORS ARE treated in much detail in an 86-page bulletin, No. GEA-1191, issued by the General Electric Co., Schenectady, N. Y. The theory of the synchronous motor is first discussed, then construction details of various motors, including the super synchronous motor are taken up, and a large part of the bulletin discusses the methods of applying these motors to the driving of various types of machinery. Tables of power factor correction, together with various diagrams, are presented, and discussion is given of some of the control equipment for these motors.

ARC WELDING OF CAST IRON is completely described and illustrated in a 12-page booklet issued by Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. The bulletin points out some of the properties of cast iron and gives a recommended procedure to be following in arc welding. Several illustrations show the characteristics of cast iron which influence its weldability, either by the carbon or by the metallic arc process. Interesting views of cast iron parts that have been repaired by arc welding are shown and the economy of the process in many cases is pointed out.

COMPLETE DISCUSSION OF the Engineering Foundation, Inc., giving its history, character and bylaws, is included in a 72-page bulletin recently issued by the Foundation which has headquarters at 29 West 39th St., New York City.

ENGBERG DIRECT-CURRENT Generating Sets form the subject of bulletin No. 106 issued by Engberg Division of Troy Engine & Machine Co., St. Joseph, Mich. Detailed views of the engine and generator parts are shown and discussed with tables of dimensions and shipping data.

METTLER GAS BURNERS and oil burners for various types of boilers, are described and illustrated in detail in a recent catalog issued by Lee B. Mettler Co., 406 So. Main St., Los Angeles, Calif.

BLACK & DECKER ELECTRIC Tools, such as drills, saws, hammers, tappers, screwdrivers, grinding wheels and the like, are completely described and illustrated in a recent 30-page bulletin, No. 20, by The Black & Decker Mfg. Co., Towson, Md.

Power Plant Construction News

Ark., Paragould—The City Council has had estimates made for a proposed municipal electric light and power plant, totaling $225,000, with equipment. The W. A. Fuller Co., 2916 Shenandoah Avenue St. Louis, Mo., is engineer.

Calif., Coachella—The Imperial Ice & Development Co., Coachella, has plans maturing for a one-story ice-manufacturing plant reported to cost about $80,000, with equipment.

Calif., Orange—The Consolidated Orange Growers, Inc., Orange, has plans under way for a three-story precooling plant to cost about $75,000, for which plans will be drawn by the Gay Engineering Corporation, 2650 Santa Fe Avenue, Los Angeles, engineer. Company also plans installation of ice-manufacturing unit at a later date.

Del., Wilmington—The Cork Insulation Co., 154 Nassau Street, New York, plans installation of electric power equipment in proposed new plant at Wilmington, Del., for which building permit has been secured for initial unit, estimated to cost about $125,000.

Fla., Jacksonville—The Florida Fruit & Produce Co., 416 West Bay Street, is said to be planning the construction of a cold storage and refrigerating plant, reported to cost more than $50,000.

Ga., Rome—The City Commission is reported planning a municipal electric lighting plant. Estimates of cost will soon be made.

Ill., Chicago—The Chicago & North Western Railway Co., 400 West Madison Street, has filed plans for one-story boiler plant on North California Avenue, to cost about $35,000, with equipment.

Ind., Milroy—The Milroy Milling Co., plans installation of electric power equipment in a proposed new flour mill and grain elevator to replace a plant, destroyed by fire a number of months ago, entire project to cost more than $100,000.

Ind., Terre Haute—The American Can Co., 230 Park Avenue, New York, plans installation of electric power equipment in proposed new factory unit at Terre Haute, entire project reported to cost about $260,000.

Iowa, Burlington—The Iowa Soap Co., plans installation of electric power equipment in proposed new plant unit to cost about $100,000. The Federal Engineering Co., Central Office Building, Davenport, is engineer.

Kan., Wichita—The Kansas Gas & Electric Co., Sedgwick Building, has plans for an equipment storage, repair and general service building on East Central Avenue, reported to cost about $400,000. C. V. Waddington is chief engineer.

La., New Orleans—The Pelican Ice & Storage Co., 1550 St. Louis Street, is planning installation of additional equipment at ice and cold storage plant for increased capacity; estimated cost not announced.

La., New Orleans—The United States Engineer Office, foot of Prytania Street, will receive bids until April 10, for one battery of three steam boilers for the United States steam boat "H. S. Douglas," as per Circular 357.

Mass., Boston—The Department of Public Buildings, City Hall Annex, has taken out a permit for extensions and improvements in steam-operated electric power plant on River Street, to cost about $225,000, with equipment.

Mass., Cambridge—The Board of Trustees, Harvard University, is arranging early construction of a steam power plant at medical school, reported to cost close to $50,000, with equipment. Densmore, LeClear & Robbins, Park Square Building, Boston, are architects.

Mich., Grosse Pointe Farms—The Village Council is having plans completed for a new filtration plant and pumping station for the municipal waterworks, estimated to cost more than $250,000. Hoad, Decker, Shoecraft & Drury, American State Bank Building, Ann Arbor, Mich., are engineers.

Mich., Lansing—The Home Dairy Co., Lansing, plans installations of electric power equipment in proposed new milk products plant, entire project to cost about $100,000.

Mich., Leland—The Michigan Public Service Co., Ludington, is said to have plans under way for a new power plant at Leland, reported to cost about $45,000, with equipment.

Mich., Munising—The Munising Paper Co., Munising, has approved plans for the immediate construction of a new power plant at paper mill, reported to cost more than $50,000, with equipment. W. A. Monroe is general manager.

Mich., Plainwell—The Michigan Paper Corporation, Plainwell, has plans nearing completion for extensions and improvements in power plant at paper mill, reported to cost more than $250,000, with equipment. C. F. Hirschfield, 2000 Second Avenue, Detroit, is consulting engineer.

Miss., Meridian—The Lauderdale County Dairies, Inc., Meridian, is said to be planning the installation of electric power equipment in proposed new milk products and creamery plant, entire project to cost more than $100,000, with machinery. M. G. Ness is president.

Mo., Hermitage—The Ozark Utilities Co., Pleasant Hill, Mo., is said to be planning a new steam-operated electric power plant at Hermitage, to cost about $80,000, with equipment.

Mo., Springfield—The Springfield Ice & Refrigerating Co., West Mill Street, is planning an addition to its cold storage and refrigerating plant No. 2, to cost about $70,000, with equipment.

Mont., Butte—The Midwest Refining Co., First National Bank Building, Denver, Colo., plans construction of a pumping plant, installation of tanks and electric power equipment in connection with an oil and gasoline storage and distributing plant at Butte, to cost about $100,000.

N. H., Laconia—Scott & Williams, Inc., Laconia, plan installation of electric power equipment in proposed new addition to knitting machinery manufacturing plant, entire project to cost more than $150,000. Lockwood, Greene Engineers, Inc., 24 Federal Street, Boston, Mass., is architect and engineers.

N. J., Trenton—The John A. Roebling's Sons Co., plans installation of electric power equipment in new addition to cable and wire manufacturing plant, for which superstructure will proceed at once, entire project to cost close to $300,000.

N. Y., Olean—The Olean Metal Cabinet Works, Inc., Exchange National Bank Building, will install electric power equipment in proposed new plant unit on Franklin Street, entire project to cost about $100,000. A. W. E. Schoenberg, First National Bank Building, Olean, is architect.

Ohio, Dover—The Greer Steel Co., Dover, has approved plans for a power plant to cost about $40,000, with equipment.

Ohio, Hamilton—The City Commission, R. P. Price, city manager, City Hall, has plans in progress for extensions and improvements in municipal electric light and power plant, reported to cost close to $80,000. The Froehlich & Emery Engineering Co., Second National Bank Building, Toledo, Ohio, is engineer.

Okla., Sand Springs—The Sand Springs Canning Co., plans construction of a one-story boiler plant, in connection with new factory on the Sand Springs Highway, entire project to cost close to $50,000, with equipment.

Ore., Klamath Falls—The Klamath Locomotive & Machine Works, care of Carl F. Gerlinger, Dallas, Ore., recently organized by Mr. Gerlinger and associates, plans installation of electric power equipment in proposed new plant at Klamath Falls, entire project reported to cost more than $200,000; a boiler is projected.

Ore., Portland—The Portland Electric Power Co., Electric Building, will make extensions and improvements in hydroelectric generating plant, known as The Three Links Power Station, Oak Grove, to cost about $125,000, with equipment.

Pa., Philadelphia—The Great Atlantic & Pacific Tea Co., 420 Lexington Avenue, New York, N. Y., plans installation of a cold storage and refrigerating plant in proposed two-story warehouse at Oregon Avenue and Swanson Street, Philadelphia, entire project to cost $300,000; structure will be occupied under long-time lease. Herman H. Kline, 709 Chestnut Street, Philadelphia, is architect.

Tenn., Tullahoma—The Tullahoma Ice & Coal Co., is planning rebuilding of portion of plant, recently destroyed by fire with loss reported at close to $30,000, including equipment. C. R. Crouch is president.

Texas, Edna—The Central Power & Light Co., San Antonio, Texas, is said to have plans for new ice-manufacturing plant at Edna, reported to cost close to $50,000, with equipment.